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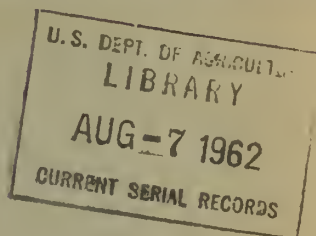
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FIRE CONTROL NOTES



A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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FEEDING FIGHTERS ON THE FIRE LINE

R. H. BLOOD

Administrative Assistant, Cleveland National Forest

For some time we have felt the need of some method of messing in fire camps that would avoid the long tiresome trek into camp for men who had spent long hours in suppression work; the turmoil and confusion that exists in camp where several hundred men are resting, eating, or changing shifts; the garbage disposal problem; the transportation from headquarters of heavy camp equipment and food supplies; chronic difficulties with cooks and kitchen help; heavy losses of perishables, due to lack of proper refrigeration; etc.

This season we decided to run an experiment during our guard school, in which men could be furnished hot food on the fire line. They could then stay in their assigned locations day and night without returning to camp for food or rest periods.

Through the local military we obtained considerable information on the method employed in feeding field groups during the war and during maneuvers. From Camp Pendleton we borrowed 10 Aer-



Food carrier with utensils separated; utensils assembled and ready to be placed in carrier; and the 10-gallon and 1-gallon thermos jugs for liquids.

Void food carriers, which are, in effect, thermos cans containing 4 trays or utensils approximately 11½ inches wide by 6 inches deep. The outside measurements of a can are 27 by 14½ inches, and the total weight empty is 52½ pounds.

These cans will hold food for approximately 50 men and the manufacturer recommends that food be placed in the containers at approximately 180°, and liquids at 200°. The 4 utensils are prepared to handle separately meat, potatoes, a vegetable, and gravy. We had hoped to try a much smaller unit, sufficient to serve 10 to 15 men, but were unable to obtain these from Camp Pendelton. However, there are such utensils on the market. The same is true of the coffee thermos. The type used was 10-gallon size, from which 1-gallon thermos jugs were filled. We are trying now to locate a 5-gallon size.

For the guard training set-up we had a total of 80 men and Fire Control Officer Stevenson desired to feed these in groups of 10 on the fire line. With the larger cans, this made it necessary to reduce the potential capacity of each container by about 80 percent, which had the effect of decreasing the period during which food in the master container would remain hot.

We obtained prices from a local caterer covering dinners of chopped steak, hamburger steak, roast beef, Swiss steak, etc., with mashed potatoes, a green vegetable, and cake. Coffee, as stated, was furnished in 10-gallon urns and distributed to the individual crews in 1-gallon jugs. The breakfast menus included sausage and eggs, bacon and eggs, or ham and eggs, with potatoes, rolls, butter, and coffee. The lunch was an ordinary box lunch containing meat and jam sandwiches and could be obtained with cold milk, handled in the same manner as coffee. The prices asked for these meals were \$1 for dinner, 75 cents for breakfast, and 60 cents for lunch.

For experimental purposes, on the second day of guard school, we delivered breakfasts to the camp at approximately 7 a. m., and in the same load sent the lunches and supper for that night. The evening meal, with coffee, was served some 12 hours after preparation and at that time was sufficiently hot. With smaller containers, or with larger crews that would permit the filling of each utensil to capacity, food would remain hot for even a longer period.

Fire Control Officer Stevenson reports as follows on the fire line feeding: "The guard training program included considerable actual line construction and the 80-man crew was broken down into small groups with crew bosses or sector bosses and instructed to remain at their assignments until relieved. Food was delivered to the end of the road in thermos containers. These containers along with knives and forks, paper cups, plates and spoons, and a small thermos of coffee or milk were delivered by pickup or weasel to the various crew leaders. Each crew boss served his own men and within 5 minutes the 80 men had been served. They had finished eating within 25 minutes. Everyone was completely satisfied with quantity and quality of food.

"A base camp was established for the sole purpose of providing a distributing point for tools and food. Camp overhead was reduced to the absolute minimum and no time was lost in bringing men into camp for meals. One man in a jeep or weasel can deliver food to a great number of men that would ordinarily have to be walked to and from

the fire line, or fed exclusively on box lunches. When the camp broke up there was no kitchen equipment to dismantle or clean, no dishes to wash except knives and forks, no garbage to dispose of, and no waste of surplus perishables. The overhead is given an opportunity to get closer to their men by feeding them and by remaining with them throughout the entire period of their employment. On an actual fire, of course, the helicopter should do an excellent job in delivering these canned meals to the men on the line.

"In future, two small units will be set up in the main camp site for heating food that is left over and to provide hot water for washing knives and forks. The latter items are the only draw-back to the operation and we will try to work out a system so that the men will not have to carry their own cutlery."

On July 1 our Pamo Hot Shot Crew was organized and sent to camp. After arrival it was found that neither the stove nor the refrigerator would operate. Repairs would take several hours. Under these conditions, we would ordinarily have to bring the 40 men back to town for food. Instead we sent from here one can containing hot supper and another with breakfast for the following morning.

On July 8, 1948, the Barrett Dam, the Rollin Hills, and Viejas No. 3 fires broke out on the Descanso district and over 4,000 hot meals were served by the method outlined above. Meals were transported 45 miles from San Diego by truck and the men were served on the line, about 20 percent of the deliveries being made by helicopter. In many cases the food had to be delivered in the 1-gallon paper containers recently received, because the master containers were too large for serving the crews of 8 to 10 men spotted at various locations on the line.

It is felt also that the regular meals should be supplemented by cold juices (grapefruit or orange juice) which can also be delivered to the line in thermos containers. We will continue to use milk with lunches, preferably in pint or half-pint paper containers. These containers can also be stored and kept cold in one of the large 10-gallon thermos. To the hot meal we plan to add a cold vegetable salad which can be kept cold either in one of the containers or in a paper carton prepared for that purpose by the Polar Ice Co.

Here in the office we find that at the end of three large fires on which several hundred men were employed our vouchering for food supplies can all be cleaned up in a matter of hours instead of the previous long-drawn-out job of rounding up purchase orders, invoices, etc., from the dozen or more grocery and meat firms. An equal amount of time was saved, of course, in not having to phone in and confirm orders to the large number of grocery stores and meat markets that we are forced to purchase from when fires occur at night or over week-ends. Without having any definite figures to go on, I would say that our actual meal costs, considering regular kitchen help, and other items, has been reduced by something like 50 percent through this method. The intangible savings are impossible to compute.

Food for 500 men, with coffee, milk, and juices, can be handled easily in the bed of an ordinary pickup.

CINDER HILLS—A SPECIAL FIRE CONTROL PROBLEM

K. O. WILSON

Fire Control Officer, Coconino National Forest

Within the northeast corner of the Coconino National Forest lies an area roughly three townships in size which is locally known as the "cinder hills." It is composed of rolling hills over which a layer of black cinders was deposited some 900 years ago by numerous volcanic cones within the area. The cinder particles average about the size of peas, are very porous, and form a layer a few inches to several feet deep. Ground cover is composed chiefly of scattered ponderosa pine, a few grasses where the cinder deposit is thin, and a sparse growth of shrubs on the north slopes. The area is characterized by patches of barren cinders which form an irregular pattern among the trees. These patches vary in width from a few inches to several hundred feet.

Until recent years these cinder hills have been cataloged as "too scattered to log," and what little logging was done on the area was confined to small tracts which supported the heavier stands. Recent heavy demands on the lumber market have caused this area to be logged rather extensively which has resulted in large areas of almost perennial slash. We use the word "perennial" because the slash deteriorates very slowly because of an almost total absence of moisture-retaining qualities in this type of formation. Extremely high surface temperatures coupled with a high infiltration rate cause moisture to disappear almost as rapidly as it falls. High burning conditions are often in evidence only a few hours after a heavy rain. Add to this a high lightning occurrence, gale force winds, and a high risk from tourists, wood haulers, and loggers, and you have a set of conditions which a fire control officer sees only in his worst nightmares.

On a windy day a fire once started in this area quickly reaches uncontrollable proportions. To put a corral line around a fire in cinders is a relatively simple operation (two RD-6 bulldozers built over 7 miles of line around a large fire this spring in less than 3 hours). To hold the fire within this line is quite another matter. Each fire follows a definite pattern, i. e., the first 24 hours the flashy fuel goes; then the fire starts to dig in. The dead windfalls and stumps are usually consumed within the first 48 hours. After the stumps are gone the fire then starts down each individual root in the root system. The porous nature of the cinders allows enough air into the ground to permit the roots to smoulder very slowly. A fire in 1947 was still burning 62 days after it started. This spring a similar fire started on the 7th of April and was still burning on the 15th of May. A burned area may go several days without showing any sign of smoke and then suddenly on a windy day be smoking in many places.

The obvious question is: "Why don't you put the fire out just like you would any other fire?" This would indeed be a tough assignment. In the first place the nearest water supply is 25 miles away, a prohibitive distance to haul. In the second place there is no mineral soil, except the cinders with which to work. In the third place, after the first 48 hours the fire has gone underground and is extremely difficult to find.

The past two seasons we have been experimenting with various techniques of control, some with disastrous results, and others with varying degrees of success. First we tried just building a control line, allowing the fuel within the line to burn undisturbed, maintaining a patrol until the fire was declared out. This fire had to be patrolled for over 2 months. The next fire we used bulldozers to bury all burning heavy fuel within 100 feet of the line under 3 or 4 feet of cinders. This proved disastrous. The fuel continued to burn, allowing the cinders to fall into the cavities resulting from the consumed fuel, and 12 days after this fire started it suddenly came to life on a windy day and, after crossing the control line in a number of places, more than doubled its original size in one afternoon.

Two valuable lessons were learned from these two experiments. The first, don't let the fire go underground, and the second, cover fuel with cinders only to prevent the wind from spotting in the daytime and uncover at night, allowing the fuel to burn as much as possible.

After the "cover-up" method failed, resulting in a serious break-over, we used an entirely different technique developed from the lessons learned on the first two trials. As soon as the bulldozers had completed the control line we immediately put them to work pushing all heavy fuel at least 300 feet back into the fire from the fire line, and rooting out all of the burning stumps within the same strip before the fire had time to go underground. This was accomplished with three bulldozers within 36 hours after the fire was corraled. In the meantime mop-up crews were patrolling the fire line and the cleared strip, picking up what the bulldozers missed. Other patrol crews were covering a quarter-mile strip outside of the fire line and picked up several small spots. Still other crews were working inside of the cleaned bulldozer strip, digging out stumps and chopping the fire from burning logs.

Seven days after the large break-over we have just described occurred, a strong wind caused the fire to make another break and burn an additional 60 acres. We employed the same technique on this smaller break that we had used on the larger, except that we covered the entire area with bulldozer mop-up, rooting out every stump within the area. This proved successful, and the fire was finally declared out 16 days after the last break-over.

An interesting sidelight on this series of fires was the use of Navajo and Hopi Indians recruited from the vast Navajo-Hopi reservation which lies directly north and east of the cinder hills. Many of them saw the smoke from the fires and rode many miles horseback to report in to their villages and trading posts. Some were transported by truck from as far as 200 miles out on the reservation.

We found them to be very well adapted to mop-up work as long as they are supervised by other Indians. Living under fire camp conditions and sleeping on the ground is their normal way of living. Dis-

cipline was excellent. The crews of approximately 20 men each, with Indian leaders, moved almost with the precision of trained soldiers throughout the camp and fire areas. The crew leaders did a remarkable job of keeping the men away from the camp area when they were off shift and moved their men through tools, timekeeping, and the kitchen with a minimum of time and confusion. Their appetites, aggravated by months of lean living, were enormous. They showed a particular fondness for bread and sugar. As soon as a camp boss learns he is going to have Indians to feed he immediately doubles the order on these two items.

We asked the leaders if a small crew of the Indians would be willing to stay with the fire, patrolling and mopping-up until the fire was out. This turned out to be a question of great importance which called for several council fires burning far into the night while the Indians sat cross-legged and blanket-wrapped before deciding who should remain. All accepted the final decision without question.

By using Indians for the long, tedious job of living with these cinder-hills fires until they are out, we are hopeful that we have struck on a solution to the ever-present manpower problem after control.

WEST VIRGINIA EPISODE

S. H. MARSH

*Regional Forest Inspector, Division of State and Private Forestry,
Region I, U. S. Forest Service*

The day before Christmas jovial hard-hitting Jim Fischer, district forester of the Pocahontas district for the West Virginia Conservation Commission, called in his men, thanked them for a job well done, and told them they could go home for the holidays. It had been raining for several days and Christmas Eve it was "spitting" snow. Everything looked safe and buttoned up for a holiday.

Jim, a newcomer on the district, had planned to gather up his family which was scattered among his kinfolk, and shake down into his new quarters. His assistants all had their own plans and looked forward to a breather, for it had been touch and go for several weeks. They were also looking forward to wild turkey and the accessories that go with Christmas in West Virginia.

It was a happy group. They jokingly recounted some of the tight spots they had gotten into, and out of, successfully or otherwise, kidded the holder of the record for the biggest fire and with ceremony cut off his shirt tail and tacked it up beside the dispatcher's map. Then all went their separate ways, with pride of accomplishment written in every line of their smoke-stained faces. Their record showed they were good. In 1 year they had fought the notoriously "hot" Pocahontas district, a troublesome area for a generation, into second place for low number of fires and area burned.

Christmas day dawned bright and clear, with a whisper of a wind. The next day, December 26, the wind rose almost with the sun and slowly gathered speed till sundown. When it continued through Saturday, December 27, it was enough to arouse the suspicions of Zara Osborne, the chief clerk, who from long experience had learned what even an apparently insignificant wind can do around the hills of West Virginia.

Was that the faint odor of smoke she smelled as she emerged from a store? She decided to find out and dashed to the office to don the radio harness. Bang, bang, bang, the reports came as fast as she could write them down until she had a list of 14 fires. Quickly deciding that this was more than a one-woman job, she spread the alarm and in a matter of minutes by radio and wire she had men racing over the hills to man their stations. The packages piled so unceremoniously on the desk when she arrived in the office remained there until early Sunday morning when all fires were manned and she was relieved.

As State Fire Chief Mullins, District Forester Jim Fischer and District Fire Chief Costilow converged on district headquarters at Logan, their radios sputtered instructions; and as key points were

manned, information began to come in, at first in a trickle, then in considerable volume. By the time they reached Logan headquarters, the fire pattern and all its implications had begun to unfold and take shape, and it was clear that trouble, plenty of it, was brewing in the four-county "hot spot" of the district centering in Mingo, the seat of a number of bloody mine wars of a generation ago.

It was not a pretty picture. It appeared that everyone with incendiary proclivities in Mingo County had selected this particular time to put them into practice. Smokes were being reported in the most inaccessible and out-of-the-way places. Wayne Shannon and Lyndell Hockman, the Mingo County protectors, with their local crews were hitting the fires hard. But it soon became evident they would need more help and relief crews as they strung out their men and pinned them down on mop-up.

After State Forester Sayers had made a quick survey by plane, calls were sent to neighboring districts for help which promptly rolled in just as Mingo began opening at the seams and the flood of incendiarism slopped over into McDowell, Wyoming, and Logan Counties.

At this point the plight of the protection organization was related to "Scotty" Harris, chief of the law enforcement division, who promptly dispatched 20 officers, led by "Tiny" Stewart (6 feet 4 inches tall), to help round up recalcitrant or reluctant fire fighters and render such other aid as might be needed. The enforcement officers were paired with fire bosses, and the manpower shortage was dissolved in spite of the prevailing holiday reluctance to fight fire. New fires were promptly and adequately manned. Old fires were fought to a finish and mopped up without break-overs.

From his master chart at headquarters, District Forester Fischer knew what crews were on what fires, when they went on duty, when they were due to be relieved, and just who would relieve them, and he saw to it that the relief kept rolling on schedule. Timing was well-nigh perfect and every man was doing his share of the work.

By Wednesday, December 31, the situation was well in hand. Every fire was covered. Those that had not been mopped up were under control. Then it rained and promptly put an end to the fires. The final score was 50 fires that burned a total of 2,600 acres.

Since the protection of West Virginia's forests was undertaken it had always been well nigh impossible to secure a conviction for a fire law violation in Mingo County. But Jim Fischer and his men either did not appreciate the significance or implications of such a tradition or were just not impressed by the historical events leading up to the fires. At any rate, when it became evident that there would be a respite from the fires, the fire bosses and law enforcement officers gathered to piece together the bits of evidence they had picked up and to discuss the next move.

The next day, New Year's, they teamed up again, a forest officer and a law enforcement officer, and began a systematic combing of the Mingo County hollows for more evidence to back up the few leads they had secured. Five or six teams usually converged on a mining camp or village, interviewing every member of each household and everyone they met on the streets or roads. Having thoroughly canvassed one hollow they proceeded to the next one, until all suspected hollows in Mingo County had been covered.

Gradually, evidence began to pile up, and whenever it pointed unmistakably to a suspect, warrants were sworn out, witnesses summoned, and prosecutions began. The score for Mingo was 25 arrests, 25 convictions. Four of the convictions were on felony charges carrying 1 year in jail. A number of cases were still under investigation this spring in Mingo, as well as in the other counties where the same procedure was followed, and other arrests have been made.

Opinions may vary concerning the efficacy of law enforcement as a fire-prevention measure but the record of the following season (spring of 1948) showed a remarkable, almost unbelievable improvement. Fires occurred at a rate of only 0.19 per 1,000 acres protected and the "burned area" reduced to 0.005 percent of the area protected. Apparently some people had learned, or had been persuaded, that "Forest Fires Don't Pay."

STRETCHER CARRIER

H. K. HARRIS

Forester, Region 1, U. S. Forest Service

The stretcher carrier has been developed for use of the air rescue squad in Region 1. It requires two men to propel and balance the carrier along trails or in open country.

The patient is carried in a modified Stokes litter, developed by the Army. This litter is supported by a single rubber-tired wheel. The wheel is equipped with a 6.00 by 6 airplane-type tire which has only a few pounds of air. This tire absorbs much of the roughness on rocky trails. The wheel has also been equipped with a brake to retard the carrier on steep slopes. A "wishbone" fork, constructed of aluminum tubing, is hinged on the bottom of the litter and supported by two rings of heavy bungee shock cord. The fork can be adjusted to give proper balance and raise or lower the litter to the best height for ease in handling. A shoulder harness is provided; it is adjustable and has slings made of webbing to carry a large share of the load. Each man uses his arms largely for balance of the carrier. The handles are removable and the carrier folds into a bundle little larger than the Stokes litter. It can be packaged for dropping and assembled for use in a few minutes.

The stretcher carrier was thoroughly tested by members of the air rescue squad, who have had experience in carrying injured men out



to car or plane transportation. The crew took turns riding and pushing over rocks, logs, snow banks, and downhill through dense brush and every form of cover obtainable. They reported the carrier satisfactory. A comparison was made of riding comfort when the stretcher was wheeled over rough rocky trails and when carried over the same trail. Surprisingly the "patient" said it was more comfortable when wheeled over the rocks than when carried.

The carrier has been adopted as part of the regular equipment of our air rescue squad, and is kept ready for immediate use.

Drawings, photographs, and material lists of the carrier are available to other regions or interested agencies. Without the Stokes litter (obtained from the Army) the cost is approximately \$75 for materials and labor.

Comparative Performance of D-6 and D-7 Caterpillar Tractors Equipped with Hydraulic Angle Dozers.—E. D. Report No. 13 was issued April 1948. Tests, conducted by the Arcadia Fire Control Equipment Development Center, covered not only work output in constructing fire lines, but also speed of transportation, load limits, etc., which must be taken into consideration in determining the size of tractor best suited to given conditions.

These tests were made primarily for the purpose of comparing performance of the D-6 and D-7 tractors. They were made under ideal conditions, so results approach the maximum rates rather than average. It is believed, however, that the information can be of great value by scaling down anticipated performances in accordance with conditions encountered.

The D-6 tractor compares favorably with the D-7, especially for fire line construction in brush-covered country. However, additional tests in timber country are necessary to complete the comparison. The comparative tests made with the D-6 and the D-7 gave the following results:

1. The D-6 may be transported by truck more rapidly than the D-7, particularly over mountain highways. The saving in time on this type of highway for the D-6 over the D-7 amounted to almost 1 minute per mile, or about 26 percent.
2. Very little difference in speed was observed in walking the two tractors on standard Forest Service truck trails.
3. In grade ability, with the blade raised, there was very little difference between the D-6 and the D-7. It might be well to point out that both tractors have considerable less climbing ability in reverse than in forward gear.
4. There was practically no difference in the cross-country travel performance of the D-6 and D-7 on side slopes with the blade raised.
5. In the construction of fire line through medium and heavy brush and up and down grade, the D-7 produced approximately 20 percent more single pass line on all slopes than the D-6. On a square footage basis, the D-7 constructed 44 percent more fire line per unit time.

In order to produce fire line at the maximum rate, the D-6 and the D-7 should work downhill on grades of 20 percent and over, even though it may be necessary to walk the tractor up the slope to permit downhill construction.

6. When cutting first from one bank and then from the opposite, it was found that, for all practical purposes, greater production was possible by changing angle of blade rather than using a straight blade.

7. In common excavation work the D-7 moved 150 cubic yards per hour while the D-6 moved 111 cubic yards, indicating 35 percent more output for the D-7. (The present D-7 is comparable to the old RD-8, and the D-6 to the old RD-7.)

The D-6 tractor costs less than the D-7 and can be transported faster by truck.

The D-7 tractor constructed per unit of time an average of 20 percent more linear feet of single pass fire line, 44 percent more square feet of fire line, and 48 percent more linear feet of fire line on 30 percent side slope. Its fire line was cleaner on single pass construction; and it excavated 35 percent more cubic yards per unit of time.

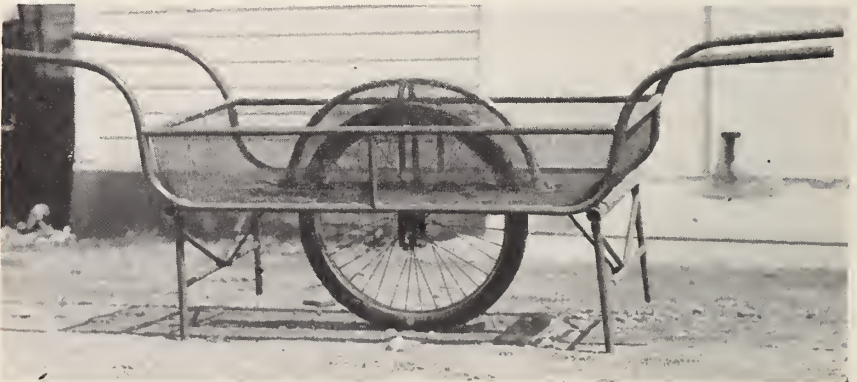
A limited number of copies of E. D. Report No. 13 are available in the Division of Fire Control, Forest Service, Washington, D. C., for distribution to concerns keenly interested in the subject.—DIVISION OF FIRE CONTROL, *Washington Office, U. S. Forest Service.*

DUFFLE CARRIER

REGION 1

U. S. Forest Service

The duffle carrier is a collapsible, single-wheeled frame for use in transporting equipment along a trail. It is arranged so it can be folded into a compact bundle for dropping by parachute. The carrier weighs 38 pounds and preliminary tests indicate it will carry 150 to 200 pounds.



During the winter, as part of the fire suppression studies, we analyzed the smoke-jumper fires to determine the mileage of cross-country travel and trail travel from the fires to the nearest road or airfield. The difficulties of this travel were also cataloged as uphill, downhill, or level, and averages determined. Our reason for this analysis was to study the problem of returning smoke-jumper equipment by means of Iron Mule or hand-propelled carrier and thus eliminate in certain areas the need to maintain pack stock and pickup men. These studies showed that the duffle carrier has good possibilities.

If an emergency does not exist, equipment in many areas would be returned to road or airfield by the smoke jumpers themselves, even though pick-up by helicopter becomes feasible.

A similar type of duffle carrier has been built for the Bitterroot Forest. Its purpose is to carry a chain saw along trails for maintenance work. Several other forests have also requested a carrier of this type.

Plans for construction of the two carriers illustrated may be obtained from the U. S. Forest Service, Missoula, Mont.

Calcium Chloride Prevents Freezing of Stored Water.—The following tabulation from Marks Mechanical Engineers' Handbook may be of interest to those who have the problem of providing stored water for fire protection at buildings during periods of freezing weather. When 100 pounds of water and solution contain a given weight of calcium chloride the freezing point of the solution is as follows:

<i>Calcium chloride (pounds)</i>	<i>Freezing point (° F.)</i>	<i>Calcium chloride (pounds)</i>	<i>Freezing point (° F.)</i>
6 -----	28	20 -----	-1.0
8 -----	24.2	22 -----	-7.3
10 -----	21.4	24 -----	-14.1
12 -----	18.2	26 -----	-22.0
14 -----	14.4	28 -----	-32.0
16 -----	9.9	30 -----	-46.0
18 -----	4.7		

If iron barrels are used to contain the water and solution, they should be painted inside with hot tar to prevent deterioration due to the calcium chloride.—DIVISION OF ENGINEERING, Washington Office, U. S. Forest Service.

A SLIP-ON TANKER FOR PICKUP TRUCKS

H. M. WHITE

Division of Fire Control, Region 6, U. S. Forest Service

The unit described and illustrated in this article was designed to fill the need, in the North Pacific Region, for a light slip-on tanker that could be hauled in a one-half-ton pickup or larger truck and quickly removed when the truck was needed for other hauling. The main features of the design are:

1. The unit is self-contained, the pumper and all accessories being mounted on the top frame.

2. Weight of tank, frame, reel, tool box, piping, and mounting brackets was kept to the minimum by using aluminum alloys. Even the bolts are aluminum.

3. A standard portable pumper, gasoline tank, and suction hose are mounted in such manner that they can be quickly freed for carrying to a water source that may be near a fire but to which the truck cannot be driven.

4. Provision is made for securing the unit in the pickup with clamps attached to the flareboard. The clamps are adjustable for different pickup body widths.

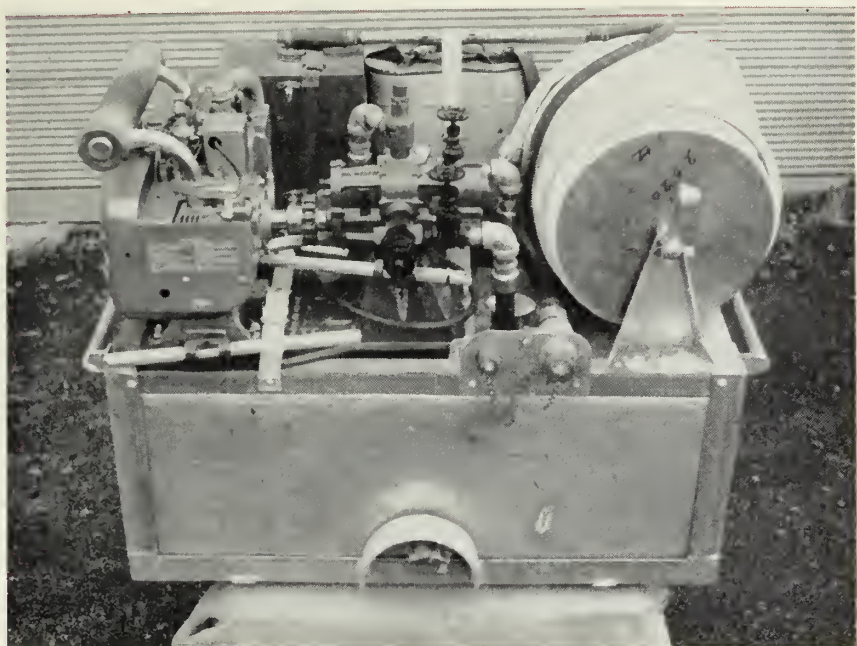
5. One-inch cotton-jacketed rubber-lined discharge hose, rather than rubber hose, is provided to keep the weight down and at the same time permit reasonably high pressure. This hose is carried on a simple reel (dead), because a reel takes less space and is considered more practicable otherwise than a basket for mounting on a small tank. The hose is coupled in three 100-foot lengths, so that if less than the 300 feet provided is needed to reach a fire it will not be necessary to unreel the full amount.

Brief descriptions of the principal parts of the unit are as follows:

Water tank.—Outside dimensions, 46 by 31 by 17 inches, with two baffles across the 31-inch dimension, three $1\frac{1}{2}$ -inch drain plugs in the bottom, and a $\frac{3}{4}$ -inch drain cock at rear. Material is No. 52-S aluminum sheet, 0.125 inch thick, except baffles which are 0.092 inch. All joints are welded.

Frame.—Material is No. 61-S extruded aluminum. The sub-frame and corners are $\frac{3}{16}$ - by $2\frac{1}{2}$ - by $2\frac{1}{2}$ -inch angle, and the skids $\frac{1}{2}$ - by $1\frac{1}{2}$ - by 2-inch H-bar. Joints are welded. The top frame is $\frac{1}{4}$ - by 2- by 2-inch channel. It is bolted to the corner uprights so that the tank can be removed for repair or cleaning. The pumper and other things are fastened to the top frame, the handles, reel, tool box, and brackets being bolted.

Reel.—The ends are No. 24-ST aluminum, $1\frac{3}{4}$ inches in diameter. The shaft is $\frac{3}{4}$ -inch aluminum water pipe, and the core six $\frac{5}{8}$ -inch No. 24-ST aluminum rods, 22 inches long, set in a 5-inch circle.



Rear view of slip-on tanker in position for sliding into pickup truck.

Tool box and brackets.—These items were made of scraps left over in cutting out the tank. The tool box is 18 by 9 by 4 inches. It carries lugs on top for the fuel tank. Suction hose brackets, at front corners of top frame, are spaced for 4-foot sections of suction hose, and will hold five. A back-pack can is carried in a bracket behind the suction hose. The can and fuel tank are secured with light web straps.

Pumper.—A rotary gear pump, driven by a 10 horsepower, 2-cylinder, 4-cycle, air-cooled engine. Capacity is 35 gallons per minute or more at 250 pounds per square inch. Lugs on the frame keep the pumper from sliding and a heavy web strap holds it down. There is very little vibration. Other kinds of portable pumpers could be used, of course, with some changes in the mounting.

Piping.—To provide for quick detachment, special cross fittings were made, with swivel connections for attachment to pump outlets. Lines to tank and discharge line to outside are made with rubber hose. All metal pipe and fittings, except certain nipples, are aluminum water pipe. To free the pump, the hold-down strap is released and the pump outlet connections uncoupled. The hose from relief valve to tank may be disconnected or left on, as desired. The relief valve is installed in the pump housing. The two gate valves shown control suction and discharge lines to tank, both 1-inch.

Cover.—A waterproofed canvas cover is provided, to fit over the entire unit. It is secured with a draw cord just below the top frame.

Hold-down clamps.—A metal clamp, or wide hook, was made to fit over the roll on the flareboard of the pickup body. It is attached to a 2½-inch heavy web strap, which is passed over the unit handle

and buckled. Two of these clamps are required. Since the unit is higher than the flareboard on most pickups, the pull is downward. On the Dodge power wagon, arrangements will be made to attach the clamp below the flareboard.

Weight.—The complete unit, dry, with all accessories, weighs approximately 475 pounds; the pumper alone, without fuel tank, 160 pounds.

Cost.—Final figures are not available as yet, but the average cost per unit is expected to approximate \$1,200. The pumper, with four 4-foot sections of suction hose, strainer, and necessary tools cost \$467.

Detailed plans of this unit are available in the Regional Forester's Office, U. S. Forest Service, Portland, Oreg.

Printing Maps on Fire Finder Disks.—In an effort to improve up the method of mounting paper maps on metal fire finder disks, a procedure has been developed to print maps of any area directly upon the painted surface of any metal disk by the use of a sensitized emulsion containing carbon particles as a pigment. The metal fire finder disks are first cleaned with steel wool or emery cloth then sprayed with 2 coats of flat ice-box white synthetic enamel. When dry, thoroughly sand side of disk to be used with very fine sandpaper. The disk is now coated with the emulsion described below by using the multilith whirler in the same manner as if multilith plates were being coated.

The emulsion is prepared from two solutions. Solution 1 consists of 3 ounces of egg albumen (flake) in 20 ounces of water. This is suspended overnight in a cheesecloth bag and strained. Solution 2 is 1 ounce of ammonium bichromate in 4 ounces of water. Combine solutions 1 and 2 and add strong ammonia water (approximately 28 percent Bohme) until emulsion turns straw yellow. This quantity (20 ounces) of emulsion will coat two disks.

To each 10 ounces of resulting solutions add 1 tube of artists' lampblack water color paste. One teaspoon of Peerless transparent water color will further improve quality of final print. It is important to dissolve pigment thoroughly and then strain emulsion. Also move air bubbles from emulsion by straining through cheesecloth before coating disk in whirler.

A Kodalith film negative is prepared for the area necessary to cover the disk and then exposed with an arc light while in a vacuum frame for a period of approximately 10 minutes. Disks are then immediately washed in water: a piece of cotton is used to clear off excess emulsion not set by light exposure. The background should be clear and white, with map details a good strong black.

When disks are dry, spray 2 coats of clear lacquer on the surface. This will insure resistance to weather and water.

While this process is being used for the first time this season, it is reasonable to believe that this type of print should not fade in sunlight since the pigment coloring is lampblack which is composed of very small carbon particles.—BURTON D. ANDERSON, *Chief Draftsman*, and EARL A. JARBOE, *Supervisor, Duplicating Unit, Region 3, U. S. Forest Service.*

FIRE FIGHTER'S BELT

GLENN A. THOMPSON

Fire Control Staff Officer, Payette National Forest

In central Idaho fire fighters often walk many miles to interior fires without accompanying pack facilities and must carry the means of individual support for a 24-hour period. The equipment for carrying must be the best to allow walking to and fighting a fire. The knapsack has been used for many years but the individual was always forced to leave it whenever he began work.

The fire fighter's belt was selected as an all-purpose carrying device that would permit the individual to be self-sufficient not only during the initial attack period but throughout each work shift thereafter. The smoke jumpers have used these belts for the past year and find that they fit their needs very well.



Fire fighter's belt with packets and items detached. Any combination of these and other items can be quickly assembled.

SOUTH DAKOTA'S JEEP TANKER

HARRY R. WOODWARD

State Forester, South Dakota Department of Game, Fish, and Parks

Since the war many fire control organizations have made various developments in the use of the jeep as a fire fighter. South Dakota has had such excellent success that our particular developments bear some discussion.

In the first place there were no facilities in our organization to provide housing and manpower for jeep units, and yet we knew that if we could get some mobile units strategically located that our fire problem could be largely solved. This speculation resulted in cooperative agreements with various fire departments in the Black Hills area. Under these agreements the State furnishes a jeep equipped with two-way frequency modulation radio to the fire department. In return, the fire department agrees to equip it, house it, maintain it, and go to any fire when called upon by the State. The State reserves the right to approve the type of equipment to be installed.

When the jeeps were requisitioned, it was specified that they be furnished with heavy duty (11-leaf) springs, and 15-inch wheels with 7:00-15 tires to help in carrying additional weight. Also specified were bumper weights to help distribute weight and the hot climate (oversize) radiator to help cool the motor on long tough pulls or long periods of idling. In addition to these features, we installed heavy-duty generators capable of producing 65 amperes at idling speeds. This generator makes it possible to operate the radio over long periods by just keeping the motor idling. A siren and the radio, a 50-watt transmitter, were also installed. The illustration shows a typical installation for the Link radio in a heavy steel box bolted to the body just above the dashboard. Installations on other units include both the Motorola and General Electric types.

The remainder of the equipment was purchased by the fire department, in most cases with county aid. First of all a heavy gage metal tank was custom built to just fit into the box of the jeep. Capacities of these tanks varied from 85 to 100 gallons. On top of the tank a Bean 101-F portable fire fighter was mounted with wing nuts to permit easy removal so that the pump can be used as a separate unit. We prefer a pump with a power unit separate from the jeep motor to give uniform pressures and to permit the development of a high pressure without overworking the power plant. With this type of pump, we found that sustained operating pressures of 400 pounds gave the best results with a minimum of deterioration to equipment. The live reel shown has proven very efficient and is recommended for all jeep tankers. By using a smaller outside diameter hose (not shown here)



Jeep tanker operated cooperatively by the Hermosa Community Volunteer Fire Department and the South Dakota Department of Game, Fish, and Parks.

which has only one braid and yet can withstand high pressures, we found that we could carry almost twice as much hose by length. The trigger-type fog gun is of great importance in water economy.

Other features included in our jeep units are hand tools of which you see a shovel and part of a back-pack pump. A McLeod tool and a Pulaski tool are carried on the left side and are not shown. An injector type tank filling unit enables you to rapidly fill the tank from a pond or stream. The maximum output of this pump is too slow for normal tank filling purposes. A spotlight and a spare can of gasoline for the pump are not shown here.

There is no evidence at this time that any of these units are over loaded. We have taken the units almost any place a pack horse can travel. They have a record of fast getaway, early control of small fires, and timesaving mop-up. As an example of how practical they are, we converted them to "Ortho" sprayers during our spring campaign against the Black Hills beetle.

MOBILE RADIOTELEPHONE SERVICE ON THE FLAT TOP EXPERIMENTAL FOREST

HERBERT A. YOCOM

Forester, Southern Forest Experiment Station, U. S. Forest Service

A radiotelephone set mounted on the fire patrol truck has proved a cheap and practical method of reporting fires on the Southern Forest Experiment Station's Flat Top Experimental Forest near Birmingham, Ala.

The set as installed in the truck includes a receiver-transmitter unit, a control unit, and a very short antenna mounted on the truck cab. Power is supplied by the truck battery. The receiver-transmitter unit is in a weatherproof box approximately 28 by 24 by 17 inches in outside dimensions. The control unit is installed on the dashboard. It includes a green light that shows when the unit is switched on, a red light and a bell to indicate when the unit is signalled, and a telephone with a "push-to-talk" button that switches the instrument from listening to talking. The receiver-transmitter unit takes up space in the truck that ordinarily is usable. The control unit and antenna use space that is ordinarily wasted.

A conversation can be carried on directly between the mobile unit and any telephone connected with the Bell Telephone system. Calls from or to the radiotelephone are handled through a regular control terminal of the Bell system in Birmingham, about 15 miles from the Experimental Forest. A special operator at the terminal makes the connection. When the mobile unit is called, the bell rings once and the red "call" lamp lights and remains on until someone answers. The horn can be wired so that it will blow when the unit is signaled. When a call is made from the mobile unit, the caller uses the "push-to-talk" button to signal the operator, who takes the number and places the call.

Radiotelephone has been used on the Experimental Forest through the fall fire season of 1947 and the spring season of 1948. When fire danger is high, the unit is turned on all the time that the patrol truck is manned. During periods of low fire danger, it is usually turned on while the patrol truck is traveling and during the noon hour.

The telephone company representative who demonstrated the unit pointed out that "dead spots" are sometimes encountered, usually in areas lower than the surrounding topography. His instructions were to drive on a short distance and try again. Although the unit on the Flat Top Experimental Forest has been used in the bottoms of hollows 400 feet lower than the surrounding topography, it has always been possible to make calls to and from the unit.

The telephone company furnishes the equipment and service for \$22 per month for local exchange calls. This charge allows for 20 outgoing calls of 3 minutes each. Additional calls cost 30 cents each. There is no charge for incoming calls, but the caller has to pay any long distance costs. There was an installation charge of \$25. The maintenance service, which is furnished by the telephone company at no cost, has been excellent.

The radiotelephone has definite advantages over an ordinary radio communication system. Radio has a higher initial cost and requires special arrangements for maintenance service. Moreover, the radiotelephone is directly tied to the existing telephone system. This does away with the need for stand-by sets and makes it possible for the operator of the mobile set to contact other telephones if the first does not answer.

Radiotelephone as a public service is relatively new. It has been available in Birmingham about 2½ years. At present, it is designed principally for urban areas, and is now in use in some 54 cities throughout the United States. The telephone company plans to expand the service as rapidly as possible. Probably the next step will be to make it available on all main highways. The distance that the service operates satisfactorily outside the urban areas varies considerably with the topography.

CHALLIS FIRE LINE AND TRAIL PLOW

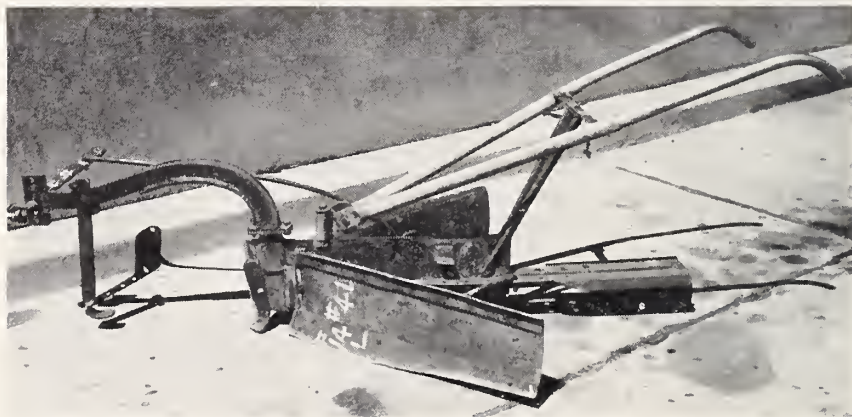
JOHN W. PARKER

Forester, Region 4, U. S. Forest Service

In our development of fire line equipment we have to keep in mind that a large part of the West does not lend itself to the use of conventional type of mechanized equipment such as tractors and tankers. The country is too steep and rough. The shovel and Pulaski are still the tools that build much of the fire line in too many cases. The hope of every fireman is that some successful gadget will be made that will do most of the job mechanically. Until that machine arrives we must make good use of the work horse and plow.

Merle G. Markle, fire control staff man on the Challis Forest, developed a V-type plow for fire lines that has possibilities. The plow will do the work if it is gotten out on the fire line with a good work horse and a trained crew. The Challis plow has developed into a good trail plow as well. Those who have used it on trail maintenance claim that it is superior to any of the other trail graders commonly used.

The Challis plow has a number of characteristics that are advantageous. A land slide prevents the plow from swinging from side to side. The handles are adjustable for individual preference and for securing better control while working on steep slopes. Wings of the V may be set at any angle and either one or both may be used. Either wing can be raised out of the way for steep sidehill work, allowing the lower or cutting wing to function at its best. The point of the V is removable and different points are used according to the work being done.



The Challis plow showing details of construction.

The depth which the plow digs can be adjusted by different settings of the coulter and the height of beam. By an adjustable clevis and pull bar the draft horse can be so applied that the plow travels in a straight line and does not tend to run to one side.

Some of the advantages of this plow over the reversible hillside plow commonly used are that it makes a wider line and digs only deep enough to remove the fuels down to mineral soil. The point of the V is so shaped that it will not get hung up on roots and rocks. This was particularly bad with the conventional plow, causing terrific strain on the plow shaker as well as the horse.

The plow weighs about 130 pounds. This weight cannot be reduced very much and still get the performance through rough going. The plow needs the weight and it needs to be rugged. It can be disassembled for packing on a horse in a few minutes.

The cost of the plow if made by hand will be approximately \$200. If it is made in quantity, this price could be materially reduced.

LITTLE TRACTORS IN FIRE FIGHTING

JOHN W. PARKER

Forester, Region 4, U. S. Forest Service

We have large areas in Region 4, as have other regions, where tractors can construct fire lines with greater speed and less cost than can men with hand tools. We know that large tractors of the D-7 or D-8 class once they are on the job can do more work and cover steeper terrain than any small tractor yet designed, but these big machines are slow to get there. Large transports with 20-ton loads move slowly over any mountain road. Short turns and weak bridges further delay them. However, for the big fires where several miles of line may be necessary the big machines are good business even though it takes them longer to arrive.

The problem is to get the small initial attack crew there soon enough with adequate equipment to control the fire before the big outfits are needed. The little H. G. Oliver tractor, Model HGP-42, built by the Oliver Corp. of Cleveland, Ohio, is a tool that promises to do much in strengthening these fast hitting crews. Some of its specifications follow:

Weight.....	3,600 pounds.
Width of tread.....	50 inches.
Length of tracks.....	6½ feet.
Width of dozer blade.....	6 feet.
Width of track shoes.....	9 inches.

In actual tests the tractor operated satisfactorily around a side slope of 40 percent without building a road to travel on. It appears stable and has little tendency to tip over. It would slide before tipping in most situations. The tractor tends to stand on its nose when backing up a steep slope, a characteristic of most little tractors. However, it moved up the 40-percent slope in reverse. Rocks and small poles hinder its climbing in reverse considerably.

The H. G. tractor can work down 60-percent slopes where rocks are not too much of an obstacle. Steeper slopes can be descended by a skillful operator if the ground is reasonably smooth. The tractor will climb slopes of 50 percent or more depending on the ground condition. The testing of the forward climbing ability of the tractor was limited because it has no fuel pump, a situation that can and must be remedied.

The tractor was operated through heavy brush including cherry, ceanothus, and willow, over terrain averaging about 10-percent slope. An adequate fire line was built at the rate of one-fourth of a mile per hour. It was the unanimous opinion that 25 men could not have done as well in the same length of time. The tractor also bucked a fire line up through similar brush on a 25-percent slope with comparative ease. By busting out a rough line up the slope and completing it on the return trip the line on the 25-percent slope was done at about the same



The H. G. tractor: *Left*, worked through this brush patch up a 10-percent slope with ease; *right*, built this 6-foot road through heavy brush on a 50-percent slope.

rate as that on the 10-percent slope. In open penderosa pine type on moderate slopes the H. G. tractor can build fire lines rapidly. As shown in the picture, a short piece of 6-foot wide trail was built across a 50-percent slope with ease. Where there is need the tractor can build itself a road.

The Beetle trail tractor lacks the power to do the fire job in any except the most ideal situations. The mobility of the Beetle is not appreciably greater than the H. G. tractor. A $1\frac{1}{2}$ -ton truck can transport the H. G. tractor easily.

There are a few bugs in the H. G. that should be corrected. It needs a fuel pump as mentioned before. There is no brake except that used in connection with the steering clutches. This is dangerous in steep country and could be remedied by having a foot brake operated by the right foot. The tractor has more power than traction and it is believed that if the tracks were 2 inches wider traction could be increased.

The premise is that if we can get a small force to any fire quickly enough after the fire starts they can control it promptly. This is a true statement for 99 percent of our fires and the force usually needs to be only a man with a shovel or water bucket. Since we cannot reach every fire in time for one man to extinguish it with these simple tools, we must provide better tools and in some cases more men. We have been quick to supply the increased number of men but slow to acquire better tools.

A 5- to 10-man crew used for initial attack equipped with back pumps, shovels, Pulaskies, a 100-gallon pumper unit mounted on a 4-wheel-drive vehicle and a H. G. tractor transported on a 1½-ton truck could be a potent force. The training of this crew, if it is to function properly, would prepare them to use the most suitable tool or tools to fight the fire at hand. There should be no hesitancy on their part to all grab shovels and go to work when the need arises. Briefly, they would not be essentially a tractor crew, but the tractor would be one of their tools to be used where it would best do the job.

Channel Iron Bed for Plow Carrier Truck.—The beds of our conventional Hi-Low semi-trailer, used in transporting tractor-plow units are usually constructed of 2- by 8-inch rough oak plank. The plank is bolted to the trailer channel sills to form the ramp and runway for the tractor-plow unit.

On a fire forest it becomes necessary to load and unload the unit many times during a season. The grousers on the tracks of the tractors soon wear out the wood flooring. In order to keep the bed of the trailer safe for transporting the tractor unit, it was necessary to constantly replace the 2- by 8-inch planks. This frequent replacement of the planking soon became quite an item of expense because of the high cost of good grade oak lumber.

Before the spring fire season started, the Ocala unit of the Florida National Forests, installed a channel iron bed on one of their carrier trucks. The channel iron used was 8 by 2 inches, bolted to the trailer channel sills with ½-inch bolts, with the cleat side up to form the floor of the trailer. Two bolts were used on each end of each channel floor piece.

To floor the 21- by 7-foot trailer bed, required 5 pieces of iron 7 feet long and 18 pieces 2½ feet long. The channel iron on the incline or ramp part of the trailer bed was spaced 8 inches apart. On the flat portion of the trailer, the 2½-foot sections of channel were used, spaced 8 inches apart but with a 2- by 8-inch plank left between each piece of iron. By placing the channel iron on the truck bed with the cleats up, good traction was obtained for the tractor tracks for loading and unloading. By having 2- by 8-inch wood pieces between each channel on the flat section of the trailer bed, the tendency of the tractor to slide from side to side while the truck is in motion was eliminated.

This change over from an all-wood to a steel-wood combination trailer bed has eliminated renewing the all-wood bed at frequent intervals and we believe will result in a more practical and safe trailer to use in transporting fire suppression tractor-plow units.

The channel iron used in making the bed cost \$87 and labor to install the pieces on the trailer amounted to \$10. During the past 5 months no replacement of the remaining wooden boards has been necessary. The steel channels take up the shock of the grousers and the wood serves as a cushion and stabilizer.—JACK THURMOND, *District Ranger, Ocala National Forest.*

PORTABLE FIELD TELEPHONE

FRANCIS W. WOODS

Communications Engineer, Region 4, U. S. Forest Service

Region 4 has attempted to help the field man in his communication problems by assembling a metal-covered field telephone that will stand all the transportation abuses common to items hauled in pickups and carried on pack mules.

The development was not a complicated process but does give us a telephone we think the men can use. The telephone instrument itself is the Army EE-8-B field telephone complete with receiver, transmitter, ringer, and call bell. The performance of this instrument is equal to any of the better Forest Service telephones. The old



leather case that came on the Army EE-8-B phone did not protect it sufficiently for the hard use our field men gave it. To overcome this a durable case 5½ by 3½ by 9½ inches was made to house this telephone. Instrument and case together weigh 11¾ pounds. Field tests indicate that the unit is quite satisfactory both from the operation standpoint and from its ability to withstand hard use. The cost of this complete unit is about \$50 if a new telephone unit is purchased. The Army EE-8-B field phone can be purchased as surplus for various prices. The cost of the durable case is about \$10 when built by hand.

HOSE WASHER

H. M. WHITE

Division of Fire Control, Region 6, U. S. Forest Service

Every year it is necessary to wash a considerable footage of fire hose, mostly cotton-jacketed rubber-lined, at the regional warehouse in Portland, Oreg. In bad years, the amount may be 50,000 or 60,000 feet. For many years, methods of washing without scrubbing have been employed, to avoid wear on the jacket.

In the first really effective washer constructed, two short pieces of 1½-inch brass pipe, each having a narrow slot about 3 inches long, were installed several inches apart, so that as the hose was drawn between them, ribbon streams under fairly high pressure were directed at the hose from above and below. A good job of washing was done by this method, except at the edges of the flattened hose.

The installation of two additional sections of slotted pipe at right angles to the first two was being considered when Roy Walker, veteran warehouseman in charge of the fire cache, had a better idea. He designed what he called a "doughnut" casting, having a slot all around the hole.

The casting is made of valve bronze and an ordinary 1½-inch swivel hose coupling is brazed to the intake. The outside diameter is 9½ inches and the inside diameter 4¾ inches. The slot is cut at an angle of 30° to the plane center line, to increase the effectiveness of the stream. Width of the slot can be varied, up to 0.020 inch, by adjusting the four bolts shown. These bolts serve a dual purpose: Slot adjustment and strengthening the casting. We set the slot at 0.006 inch and use 200 pounds pressure.

The box in which the casting is installed can be constructed in various ways, of course. We use a box, 34 by 15 by 12 inches, made of ¾-inch waterproof plywood. The bottom consists of two pieces, sloped toward an opening at the center to let the water out. The ends have holes through which the hose is drawn and the casting is installed across the center, with the slot facing the entrance.

To support the hose as it is drawn through the box and casting, we use two assemblies of 16¼-inch rods about 15 inches long, set in a circle somewhat smaller than the inner diameter of the casting. These rods do not extend through the casting, as they would interfere with the stream. Their ends are set in brackets, attached to the four bolts. The forward assembly is about ¾-inch above the slot at the bottom so that the hose will not rest on the casting. The rear assembly is lower, so that the hose couplings will not catch on it.



"Doughnut" hose washer in same position as installed in box.

Preparatory to washing, coils of hose are soaked in a large tank for several hours to soften caked dirt. Then the hose is drawn through the washer and out onto the test and drying rack as fast as a man can walk. It comes out thoroughly cleaned of everything that plain water will remove. Water is supplied from an electrically driven gear pump.

Since the patterns for the casting are owned by the Forest Service, anyone desiring to purchase one may order from the Supply Officer, 2760 Northwest Yeon Avenue, Portland, Oreg. The one we have costs \$5.75, exclusive of patterns and machining. The price would probably be somewhat higher now. The machining costs much more than the rough casting, of course. It could be done locally from a drawing to be supplied, or the Portland supply officer could have it done, if the purchaser desired.

PROPANE-DIESEL OIL FLAME THROWER

A. B. EVERTS

Fire Staffman, Snoqualmie National Forest

The October 1946 issue of Fire Control Notes described a flame thrower developed by the Los Angeles County Department of Forester and Fire Warden in which butane was combined with Diesel oil to produce an exceedingly hot flame for heavy backfiring jobs. In the Los Angeles unit, a compressor was used to pressurize the Diesel oil and, of course, an engine was necessary to run the compressor.

A somewhat comparable unit has been developed on the Snoqualmie National Forest which utilizes the gas pressure in such manner that an engine and a compressor are unnecessary. This is done by using propane instead of butane. The reason propane will perform the pressurizing function while butane will not is the difference in pressures at given temperatures as shown in the following tabulation:

Tank temperature (degrees) :	<i>Pounds pressure</i>	
	<i>Propane</i>	<i>Butane</i>
40-----	63	3
60-----	92	12
80-----	128	23
100-----	172	38

B. t. u.'s per pound of liquid are: Propane 21.633; butane 21.331. Propane will start to vaporize at -44° F., while butane needs a temperature of 32° .

The Snoqualmie unit, also trailer mounted, is made up of two standard ICC, 600-pound test, 48-gallon propane tanks, to which have been added the necessary fittings, a hose basket, three 25-foot lengths of one-half inch Buna S-lined neoprene hose, and torch (fig. 1). The hose basket is welded to the tanks and provided with lifts, so that the whole unit can be removed from the trailer with a chain block.

The gas tank, not visible in figure 1, has a 10-percent valve, a top outlet valve, and a pressure relief valve, which is set at 300 pounds. The oil tank (shown) is identical except that it has a $1\frac{1}{2}$ -inch top filler vent for Diesel oil, a copper tube which runs to the bottom of the tank to release condensed moisture, a Davies type pressure release valve, and a pressure gage. Oil is released through the valve in the center of the head. A down curving tube runs through the center of the oil tank to within 1 inch of the bottom.

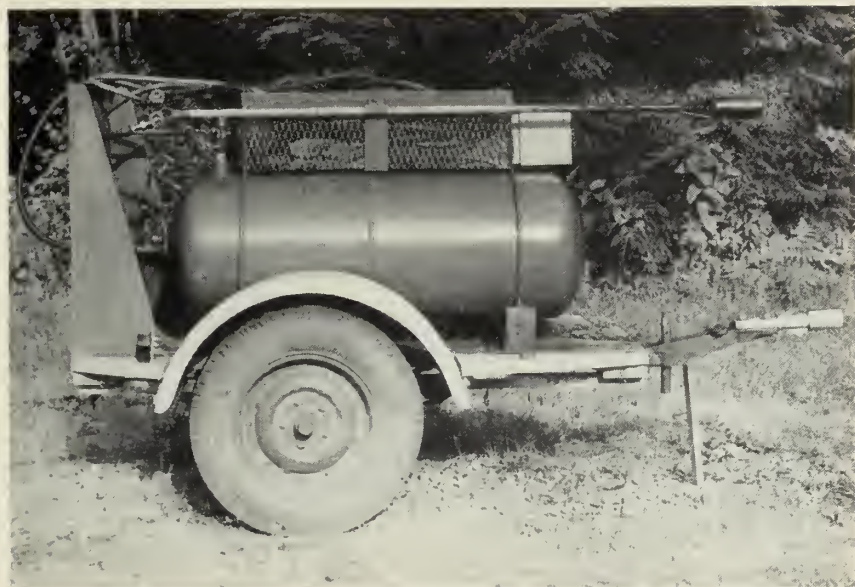


FIGURE 1.—Trailer type propane-Diesel oil flame thrower. The wooden end piece at rear is for protection of valves.

A copper tube runs from the gas tank to the oil tank to permit the propane to pressurize the oil, usually from 75 to 125 pounds. When the oil tank is empty, pressure is relieved through the Davies type valve and the tank is refilled. This valve is a standard safety installation for this type of equipment. If the escaping gas should be ignited, the screen on the valve would prevent the flame from getting into the tank.

To fill the gas tank, a standard propane tank is up ended and elevated so that the liquid gas will flow through a special hose. The 10-percent valve is opened slightly to allow the air or gas to escape. When the incoming liquid gas reaches the 10-percent valve, a mist is released, indicating that the tank is filled to the safe working level.

The torch is 6 feet long. It is made of 1-inch stainless steel tubing, with a naval bronze mixing cap at one end and two valves at the other, one for gas and one for oil. In hard-to-ignite fuels, such as old logging landings, the gas discharge may be reduced and an excess of gassified oil applied to the fuel, after which the gas is turned on full again to produce a flame as shown in figure 2.

The reason for breaking up the hose supply in 25-foot lengths is the high friction loss in small hose. The pressure obtainable from the propane tank is sufficient for a reasonably long flame throw with 75 feet of hose, but where that much is not needed, it is desirable to use a shorter length and thus increase the flame throw.

Freezing, which frequently occurs in any liquid as it converts to gas, has not been a problem with this unit. The reason is that the



FIGURE 2.—Propane-Diesel oil torch with oil and gas turned on full.

freezing is in direct relation to the surface area of the liquid, and with the tank lying on its side the surface area is sufficient to prevent freezing.

Two of the trailer units were purchased for ranger use. They were so well received that a third ranger, with a large amount of slash to burn, also wanted one. By this time an improvement had been added. Why should the propane tank be filled when tanks provided by the oil companies can be used just as well? In this case, when a gas tank was empty, it could be replaced with a full one. There was only one problem: with a full tank lying on its side, liquid would be drawn off instead of gas. This was solved by installing a vaporizing cylinder, 6 feet long and 6 inches in diameter. The gas enters the vaporizing cylinder on the bottom as a liquid. It is withdrawn at the top as a gas to pressurize the oil tank and to furnish gas to the torch.

At this writing the three units described have been used to fire sagebrush in a range reseeding project, burn out a slab and sawdust pile at a small mill, fire log landings, set slash fires, and burn piled brush. It has been suggested that it might be a formidable weapon to fight the invasion of Mormon crickets which occur periodically in some of the Western States.

From experience gained so far we believe one filling of propane on the trailer unit will last through 4 or 5 days of judicious burning. About one tank of oil is required daily.

Pressurizing oil with propane gas is the idea of a Seattle manufacturer, who has applied for patent on the idea as well as on the dual control torch which is used with the unit.

Since a heavy unit, as described, is limited to roads and tractor trails, there is need for a companion unit for use on rougher and steeper terrain. Such a unit is shown in figure 3. In theory, it



FIGURE 3.—Improved back-pack propane torch.

operates in the same manner as the propane torch shown in the Fire Control Equipment Handbook. Its advantage over the old type is that, while it carries nearly twice as much propane, it weighs only 45 pounds as compared with the 47 pounds of the old type. The tanks are shatterproof stainless steel oxygen tanks tested to 600 pounds and provided with a safety release set at 175 pounds. The tanks are mounted on a plywood packboard which gives protection from freezing not provided in the clack board mounted older type. The torch is light and has a thumb controlled valve. A 10-percent valve is provided for safety in filling.

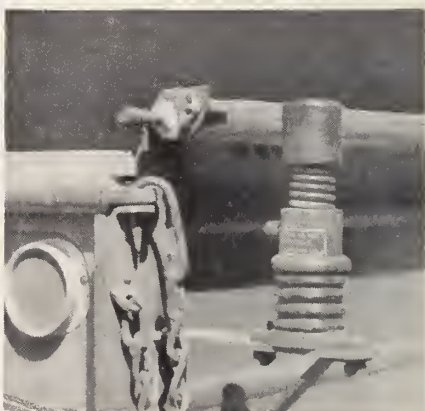
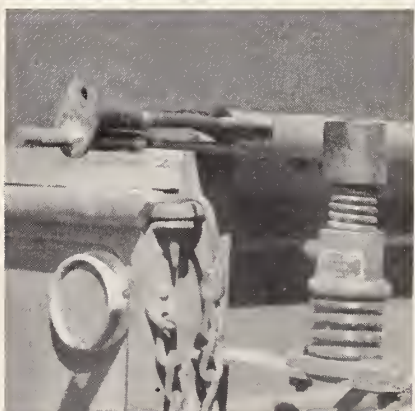
In a later version of this torch, one tank is used for Diesel oil which, as in the trailer unit, is pressurized with the gas. This unit has two hose lines. It can be used with both tanks filled with propane or with one tank of gas and one of oil.

CARRYING A TWO-SECTION WHIP ANTENNA FOR PORTABLE RADIO

DON M. DRUMMOND

Assistant State Fire Warden, Nevada

Elko County is one of the largest counties in Nevada. It is bigger than the combined area of the three smallest States in the Union. In this sparsely settled country, single fires have been known to burn thousands of acres of range forage. Ranches, including the hay



Steps necessary to put the antenna away for carrying : A, Dismount antenna from base mounting spring and loading coil ; B, fasten carrying cap to two sections of antenna ; C, slip antenna into "carrying case"—rolled edge of pickup bed ; D, fasten cap with wing nut, stored antenna is in travel position.

stacked for winter, miles of fences, ranch buildings and homes, have at different times gone up in smoke. Communication is a vital problem in fire control work on such a large area with so few people.

Through Government surplus the Nevada State Board of Fire Control and the Nevada Extension Service secured several portable radios—Fisher type RS253 and TW253. Elko County is experimenting with them. The county fire warden has learned that the vertical two-section whip antenna is too heavy and tall to be left mounted during all his miles of travel. The radio sets are portable—not mobile—requiring that he stop his vehicle before using the radio. He must carry the antenna where it is well protected, and also in a position where it is easily and quickly available. He slips the two sections of the antenna into the rolled edge of the pickup bed and holds the ends of the antenna firm with a special cap he has fashioned. A wing nut holds the cap and antenna “in storage.” The antenna can be unpacked and set up in a matter of moments.

BACK-PACK PUMP CARRIER

JOHN W. PARKER

Forester, Region 4, U. S. Forest Service

The back-pack pump can has become a standard piece of fire fighting equipment in several sections of the country. These cans are carried in trucks, pickups, tankers, and other vehicles. The problem is to have a carrier that will hold these in place so they will not get damaged or spill the water when being hauled. The safety of the men who ride in the vehicle is also involved. Quite frequently a pump can must be carried in an administrative pickup being used for other work and it is necessary that it be placed on the running board or other convenient place where it will not be in the way. There are several pump carriers on the market but they are expensive and usually will accommodate only one make of pump can.

The Wasatch Forest developed a back-pack pump carrier that can be constructed cheaply and can be made to fit any shape pump can. The Wasatch pump carrier requires the following materials with their estimated costs:

2 pieces 2- by 6-inch lumber-----	\$0. 25
1 piece leather strap 1½ by 36 inches with buckle and keeper-----	1. 50
1 screen door spring, extra heavy type-----	. 15
1 piece 5-ply plywood for bottom-----	. 25
Total material cost-----	2. 15
Labor to assemble-----	1. 50
Total cost-----	3. 65



Left, top view of pump can carrier. Right, pump can mounted in carrier.

The screen door spring is attached to the bottom in the form of a loop. The leather strap is fastened to the loop. With this arrangement the strap when buckled is under constant tension from the spring, thus holding the can firmly in the base.

Two bolts will hold this carrier securely to a truck bed or a running board. Two brackets will hold it on the side of a vehicle if there is no space available on running board or truck bed. A detailed plan for the back-pack pump carrier may be obtained from the U. S. Forest Service, Ogden, Utah.

Ruidoso.—Ruidoso, N. Mex., has been something of a fire problem to the Lincoln National Forest, which surrounds it, for a number of years. The town is situated along the Ruidoso River on a stringer of patented land 4 miles long and ranging in width from $\frac{1}{4}$ mile to $1\frac{1}{2}$ miles in the heart of the ponderosa pine type. This 4-mile strip of private land is traversed by the main road or main street, with only one outlet to the north over a secondary road at about the midpoint.

Prior to 1920 Ruidoso was just another small, mountain country community. The local people were dependent on farming and ranching. One or two small sawmills operated on a part-time basis and contributed very little to the local economy.

By 1925 Ruidoso had grown. There were a number of summer cabins constructed along the river and people were spending the summer months there. It was considered advisable for the District Ranger to maintain a summer camp in Ruidoso to take care of the fire problem. At this time, "everyone" except the postmaster left Ruidoso in September, came back in November to hunt, then stayed out until the following May or June.

Ruidoso continued to grow; and so did the fire problem. To get some idea of the magnitude of this problem, one must consider that Ruidoso grew within a short time from a summer home group into a thriving summer resort with crowds estimated at 12 to 15 thousand for week ends and 18 to 20 thousand for the Fourth of July celebrations. The fire problem remained the responsibility of the Forest Service. Key individuals in Ruidoso gave excellent but limited cooperation.

In the early development of the Ruidoso area the Forest Service realized the responsibility of local fire protection belonged to the town of Ruidoso. However, the situation was such that it was necessary to protect Ruidoso in order to protect the forest. At times the outlook was very discouraging. Lack of fire-fighting equipment was a handicap to both the Forest Service and the town. Rakes, shovels, and back-pumps were standard equipment up to 1939. In 1939 an Edwards pumper and 1,000 feet of hose was purchased for the Ruidoso area; in 1945 a tanker truck was added. In 1948 a new up-to-date fire engine was purchased by the town.

At the spring fire meeting this year the Ruidoso fire department took over the responsibility for suppressing all fires in the Ruidoso area, the Forest Service to assist when called upon. The Forest Service was to handle all fires outside the area, the Ruidoso fire department to assist when needed.

To me two points in handling this problem are outstanding; the number of man-caused fires and property loss have been held to a minimum, and the working relations between the town of Ruidoso and the Forest Service have been very good at all times.—LEE BEALL, *Range Conservationist, Lincoln National Forest.*

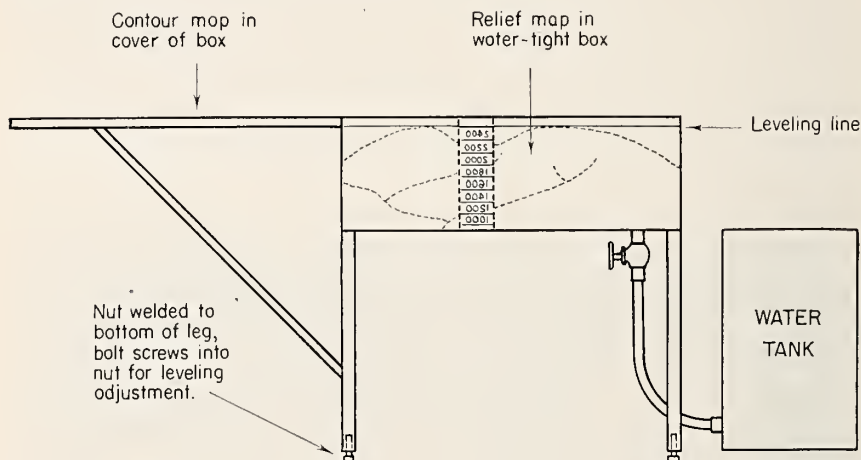
DEVICE FOR TEACHING CONTOUR MAP READING

RALPH G. BROWN

District Ranger, Stanislaus National Forest

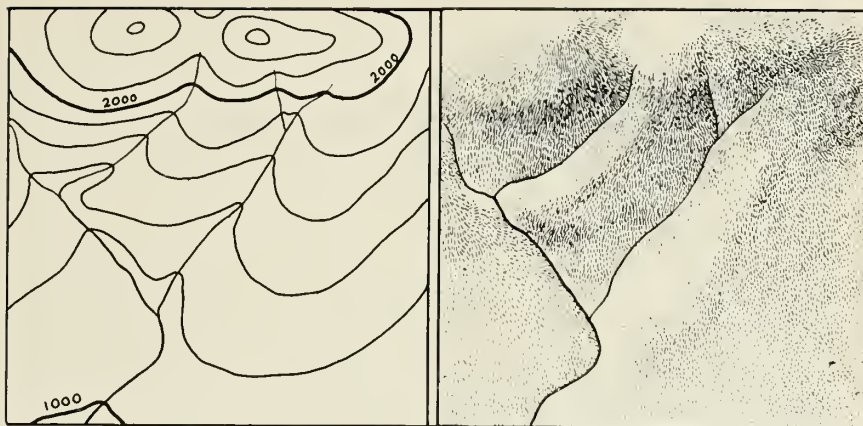
Device consists of :

1. Water tight box with legs adjustable for leveling.
2. Relief map built up inside of box showing peaks, saddles, ridges, creeks, various slopes, benches, etc.
3. Line marked inside of box, near top, to use as leveling guide with water.
4. Vertical scale mounted inside of box, graduations coinciding with contour interval.
5. Drain installed through bottom of box.
6. Water container capacity equivalent to map box, connected by rubber hose and shut-off valve to drain.
7. Contour map mounted in lid of box, depicting the topography of the relief map and on the same scale. Contours numbered to correspond with those on the vertical scale in map box.



How used :

1. Map box set up and leveled.
2. Shut-off valve opened and water tank raised above level of box allowing relief map to be flooded. If dye or other coloring matter is added to the water to make it opaque it is more effective.



CONTOUR MAP

RELIEF MAP

3. Valve shut off and tank returned to position below box.

4. Valve cracked to bring water level down to number on scale representing highest contour on contour map. *Water line on relief map corresponds and represents contour line on contour map in lid of box.*

5. Crack valve and lower water to next graduation on vertical scale. Repeat process for each contour with explanation.

SPIRAL ROTOR TRENCHER

T. P. FLYNN

Equipment Engineer, Region 6, U. S. Forest Service

The spiral rotor trencher is a light-weight, motor-driven machine being developed for fire-line construction. A revised pilot model was completed and given preliminary field tests 3 times in June and July 1948. The most recent test was conducted at high elevation in the Cascade Range on the Mount Hood National Forest.

The most noteworthy mechanical feature of the machine is the 2-way tapered, spiral rotor digger or trencher tool, a positive excavator type rotating between 250 and 300 revolutions per minute.



Trencher showing arrangement of the spiral rotors.

Power is supplied by a 6-horsepower, 4-cycle Salisbury motor. The spiral excavator uses about 70 percent of the power and the traction wheels about 30 percent. Power steering to the tractor wheels is incorporated and appears well worth while in that it greatly reduces fatigue of the operator. Positive chain drive propels the spiral rotor and delivers the primary power to the rear wheels.

An important improvement in the latest revision of this machine is an automatic slip clutch installed in the power drive line to the spiral rotor. This slip clutch goes into action when excessive overloads are caused by collision of the rotor with immovable objects. It dissipates a large amount of shock that otherwise would reach the motor and main transmission. This feature is well worth the additional cost involved because it serves as insurance against breakage of valuable parts in the transmission.

Traction wheels are 24 inches in diameter and 24 inches apart (center to center). The axle is 12 inches from the ground with the transmission partly underslung. The complete unit, which weighs 500 pounds in its present form, has a low center of gravity and good stability for rough country operations. Its travel speed is 1 to 1.3 miles per hour.

Ground conditions for the tests made on the Mount Hood generally would be considered difficult for almost any size of machine, because of very frequent and heavy lava rock outcrops. Specifically, the average ground condition in which the trencher was used classified as about 75 percent red clay soil and 25 percent small boulders from 4 to 8 inches in diameter. Cover consisted of a heavy stand of pine timber with a heavy undergrowth of small manzanita brush; quite a few down logs and broken limbs were present on the surface. There was usually sufficient space to maneuver the trencher around the large logs and between the heavy patches of manzanita brush as well as between the rock outcroppings.

To determine the limitations of the spiral rotor trencher, its durability, output, and quality of trench under rough conditions, and its ability and effectiveness in general, trenches were made up steep grades, on sidehill, downhill, and on the outer fringes of heavy rock outcrops.

Stop-watch checks showed that in reasonable ground conditions, at least 20 percent rocks and boulders in this case, excavating speed was approximately 1.1 miles per hour. This speed allows the operator just about the right amount of time to pick his course. Trench width averaged about 22 inches of actual excavation and the berm of cast out materials on each side averaged about 7 inches. Although the depth of trench could be controlled easily by the operator's handle, an average depth of 4 to 5 inches was used as a standard, principally because this depth permitted the outer ends of the spirals to clean up the outer edges of the trench and leave a neat line without any fall-back.

The tendency of the rotor is to dig or excavate at all times without any excess force applied from the operator's handle. It does not lead into the ground fast or suddenly, and when it encounters immovable objects, such as large boulders or roots, the rotor automatically climbs and slides over them.

The spiral tool excavates and pushes dirt both ways from the center. Its taper in diameter from the center outward accomplishes two things: Reduces excavating load pressure on the outer ends of the tool, and



Trencher in action. Note splash and the clean trench constructed.

tapers the bed of the trench upward toward both edges. The excavated materials deposited at the edges of the trench remain very firm so that fall-back is practically negligible.

The spiral splashes dirt about 2 feet from its outer ends. Although it was not intended that this pattern of spiral was to throw dirt very far, the small splash would be beneficial when working close to a fire line.

One interesting discovery about the behavior of a spiral rotor working at right angles to the line of travel, made during earlier experiments, was that better results are obtained when the spiral rotates in the opposite direction from the tractor wheels than when it rotates in the same direction. Rotating the spiral in the same direction as the wheels, instead of providing some forward traction as well as excavating, resulted in a tendency to climb out on top of the ground and otherwise leave ragged edges to the trench. Rotation was reversed and the spiral now does its excavating on the upturn, coming from underneath against the cut. The spiral rotation now used leaves a neatly excavated and highly satisfactory fire trench.

At this stage there appear to be only a few adjustments, such as reducing the travel speed some to favor the operator when excavating in difficult ground, and simplifying and streamlining the power transmission to the tractor wheels. The spiral trencher tool is the outstanding feature of the machine and its shape and relatively low rotating speed reduce the possibility of damage or breakage to a minimum. The 6-horsepower motor used is adequate. The proportion and balance of the machine appear to be quite satisfactory.

DRIVEN WELLS FOR FIRE SUPPRESSION

EDWARD RITTER

Region 7, U. S. Forest Service

An old story need not be often repeated unless it serves a particular purpose. There is little new in this story as it describes the use of water on forest fires. But because it deals with a specified locality and individual fires, it is thought the information may be of interest to others. The area is Cape Cod, Mass.

Growing up as a westerner and working on forest fires in the dry ponderosa pine type of the Inland Empire has tended to make me water conscious if only from a standpoint of having sufficient drinking water on the fire line. In 1930 while reading accounts in the Idaho Statesman of the serious forest fires in the East little did I think that some day I would be back there and find out firsthand what some of their problems were. Cape Cod, instead of being the mass of sand dunes I had expected, turned out to be a relatively rugged area of forest land, much of which is strewn with massive boulders and rock formations. The use of driven wells did not look very practical at first but the district fire warden, Massachusetts Department of Conservation, had progressive ideas and wanted to prove to his satisfaction that driven wells could be used to advantage on forest fires.

Use of water from driven wells for forest fire suppression is not unique although it is believed that the following instances, described by E. Ormand Dottridge, district fire warden for the Cape Cod area with headquarters at Cotuit, Mass., may serve as reminders of what might be accomplished elsewhere under certain conditions.

The Horse Pond fire which occurred at 3:40 p. m. on August 24, 1947, on a class 3 day was controlled before midnight of August 24, mopped up and declared out at 4 p. m. August 25. Although the fire was only about 5 acres in extent, 1,100 feet of line was bulldozed between two ponds to aid in corral, and the remainder of control and mop-up was completed entirely with the use of water. Fourteen thousand and three hundred gallons of water were applied through use of 5 fire trucks and 83,140 measured gallons were applied by 2 portable power pumps using the ponds as a source of water although driven wells would have served satisfactorily. Only 2 hose lines were used, each about 500 feet in length.

On August 6, 1947, at 11:15 a. m., a fire started near South Mashpee. It was a class 3 day, but only $1\frac{1}{2}$ acres burned. The fire was knocked down by use of a county brush breaker and a town fire truck. A portable power pump was attached to a hand-driven 2-inch well pipe with a common button point and a 60-mesh screen. The well was placed in about the center of the burn and 200 feet of $1\frac{1}{8}$ -inch rubber-lined hose was sufficient to accomplish the complete mop-up job. A one-quarter-inch nozzle tip was used and an average of 12 gallons per minute was pumped. Between 4:30 and 9:30 p. m. August 6, 3,600 gallons were played on the burn and 4,320 gallons between 8:30 a. m.



Portable pump at work on South Mashpee Fire, Cape Cod, Mass., August 1947.

and 3:30 p. m. of August 7. Seven tank trucks were used to apply 9,080 gallons of water on the burn during the 2 days, making a total of 17,000 gallons.

District Fire Warden Dottridge stated it took 20 minutes from the time the equipment arrived on the scene until water was being pumped on each of these two fires. He has loaded on a half-ton pickup truck a set of equipment which includes 2,400 feet of $1\frac{1}{2}$ -inch linen hose, 400 feet of $1\frac{1}{8}$ -inch rubber-lined cotton-jacket hose, two portable pumpers, suction hose, Siamese fittings, adapters and nozzles, two back-pack pump cans, two 5-gallon cans of gasoline, one 2-gallon gasoline can, a small complement of hand tools and the well equipment.

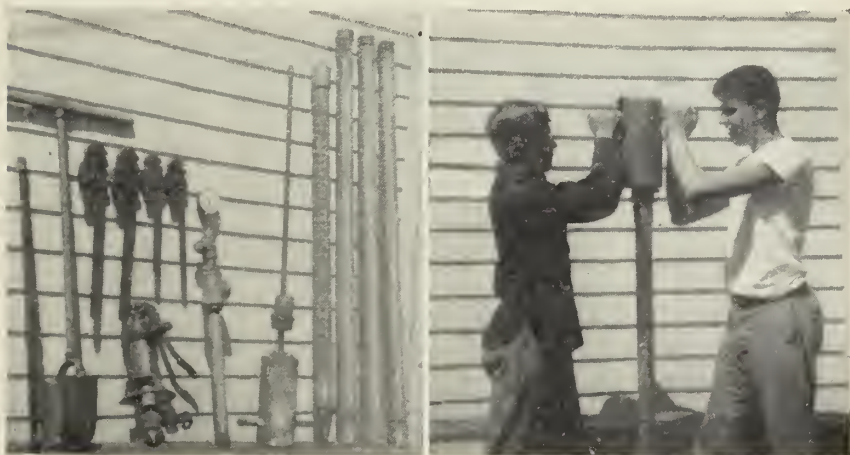
Driving a well point is not so mysterious as it is laborious. The accompanying photographs illustrate what tools and equipment are necessary and show how they are used. A list of the materials purchased by the Massachusetts Department of Conservation is as follows:

<i>Quantity</i>	<i>Item</i>	<i>Estimated cost</i>
1	2- by 48-inch washer well point.....	\$12.00
3	5-foot lengths, 2-inch galvanized threaded pipe.....	12.90
1	2-inch galvanized tee.....	.82
1	2-inch galvanized plug.....	.20
1	2- by $1\frac{1}{2}$ -inch galvanized bushing.....	.28
1	2- by $1\frac{1}{4}$ -inch galvanized bushing.....	.28
1	2-inch malleable iron drive cap.....	.50
4	2-inch wrought steel couplings.....	1.76
1	2-arm well driver, 60 pounds.....	5.00
1	3-inch pitcher pump.....	5.10
1	$3\frac{1}{2}$ -inch vacuum gage.....	9.60
2	24-inch pipe wrenches.....	9.50
2	18-inch pipe wrenches.....	5.50
1	$1\frac{1}{4}$ -inch galvanized pipe, threaded on both ends ($1\frac{1}{2}$ -foot length).....	.85
1	$1\frac{1}{2}$ -inch smooth bore suction hose, female couplings (4-foot section).....	3.52
Total.....		67.81

Driving the well is simple. First dig out a few scoops of sand or gravel with a round point shovel and post hole digger until the water table is reached. Then place the well point in a vertical position and begin applying muscular action to the 60-pound well driver which can best be operated by two men. When the well point has been driven into the ground sufficiently, make fittings of a 2-inch tee, vacuum gage, pitcher pump, and gate valve. Next, attach suction hose from pump and all is in readiness to start pumping water. When there is no further need for the well, the point may be pulled or it may be capped for future use if desired.

Points which are well to remember if one is interested in trying out driven wells on his district are listed here for consideration.

1. A fair knowledge of the local water table level and wells already driven in the immediate area should be helpful.
2. Study geological survey maps, water levels in adjacent ponds, streams, and swampy areas.
3. Confer with persons using driven wells in the adjacent area at similar levels.
4. Test wells by stand-by crews in areas likely to be used for underground water supply in case of fire.
5. Consult engineers who have made surveys of ground water supplies for municipalities.
6. Ten gallons per minute should be expected from a 2-inch by 4-foot, 60-mesh well point under poor to average conditions and much more under favorable conditions.
7. A series of two or more points may be driven at intervals of 10 or more feet.
8. Any type of pumping equipment may be used.
9. Avoid if possible heavy vacuum on shallow wells. There is danger of rupture of the button screen which would allow sand or gravel to enter the well and possibly ruin a gear pump.



Left, equipment necessary for well driving includes post hole digger, pipe wrenches, pitcher pump, well head assembly with vacuum gage, 60-pound well driver, button type drive point, and three sections of well pipe. *Right*, driving the point is laborious, but two men can complete this operation in a few minutes.

10. After well is driven, use pitcher pump to pump off discolored water into a container. If sand or gravel shows in bottom of container, use caution in operating gear pump. Discolored water may persist indicating for example, swamp water. This will not be harmful so long as there is no evidence of sand or gravel.

11. Take a sample of water from the pump occasionally to determine if button has been ruptured.

12. After pumping for an extended period an increase in vacuum may be noted. This may be due to the draw-down. Vacuum should remain fairly constant with a steady rate of demand by the pump. A constant increase in vacuum might indicate unfavorable soil conditions or rupture of a button screen, and that the well is filling up with sand or gravel. A sudden increase in vacuum would probably indicate rupture of the button screen. These points must be given consideration during all trials and careful observations should be made to avoid damage to equipment so that best results may be attained.

District Fire Warden Dottridge feels that the possibilities of using water from shallow wells may be greater on his district than he had first anticipated. He says, "why lay hundreds or thousands of feet of hose if there is usable water a few feet underground that can be tapped by use of wells?"

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

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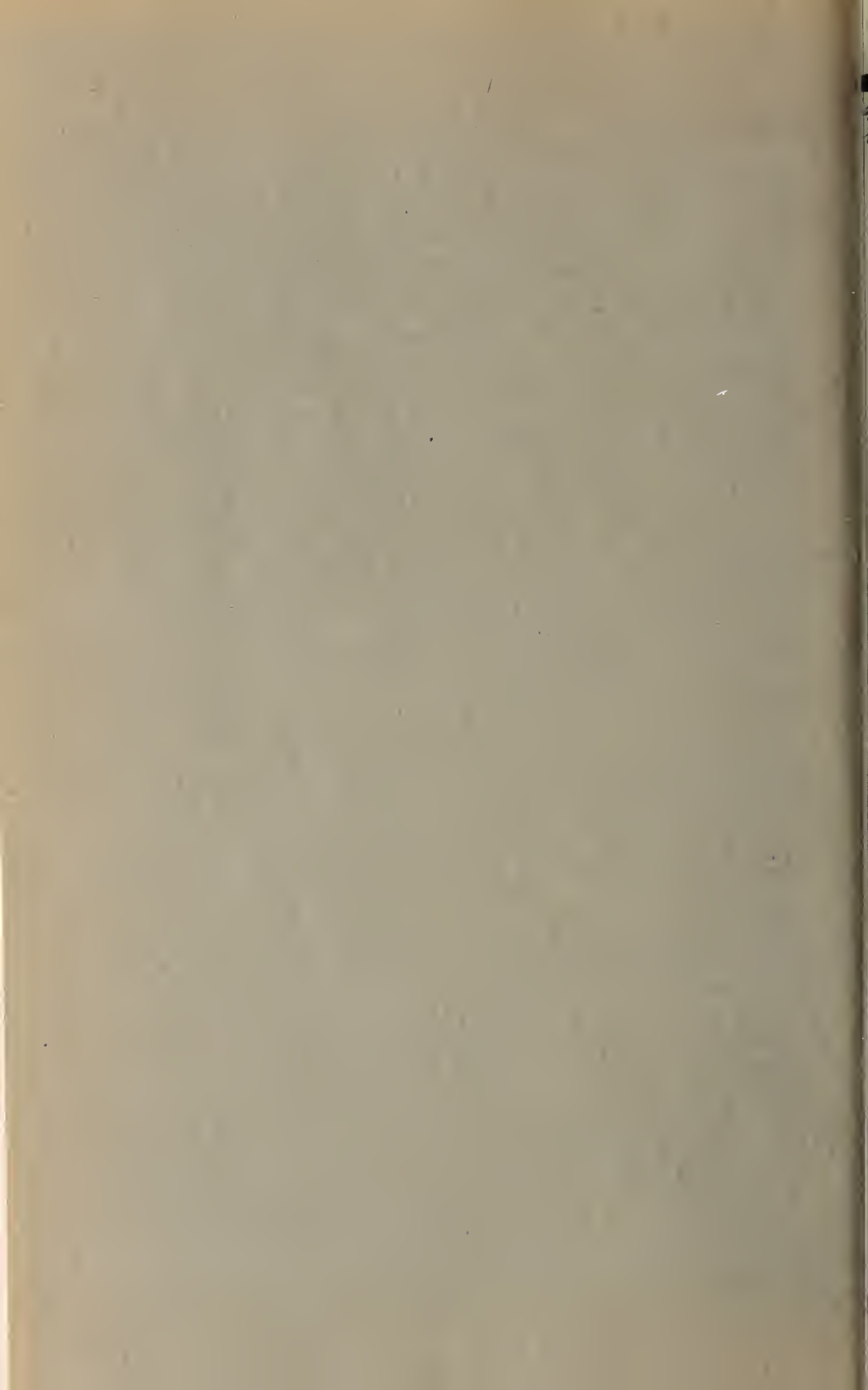
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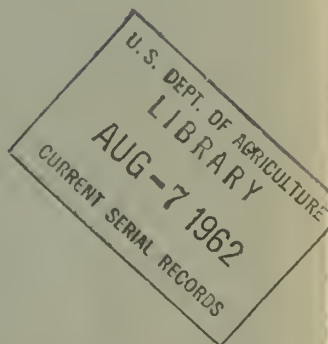
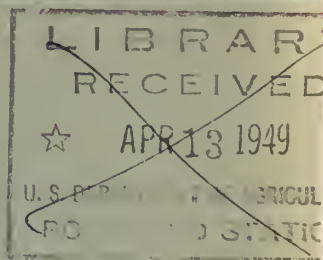
CONTROL

NOTES

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April 1946—April 1949



A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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SLASH PILING BY MACHINE ON THE SOUTHERN IDAHO FOREST PROTECTIVE DISTRICT

ART ROBERTS

State Fire Warden, Southern Idaho Fire Protective District

Since the spring of 1945, it has been possible for logging operators on State and private lands in Idaho to contract their slash-disposal job to the State forester at a more or less stable rate on a State-wide basis. The law is written so that any job may be taken on its own merits, but in practice, unless the job is exceptionally difficult, it is taken at the base rate. The actual disposal work is delegated to the State fire warden on the district involved. On the Southern Idaho Forest Protective District there is almost 100-percent cooperation under the law. For this reason, it is possible to consider the problem on a district-wide basis. Roughly, the area is broken into two units and each job is considered with relationship to the large unit. Our use of machines has been pretty well confined to the northern unit which embraces the McCall-New Meadows-Council area.

For the most part the type is yellow pine, and on quite a lot of the area the slope is gentle and the ground open. For this reason, we became interested during 1945 in operating a tractor or two on some of our slash-disposal jobs. Some work had already been done along this line elsewhere and we looked into the results obtained on some of these jobs. Late in 1945 several fire wardens visited the Biles Coleman Lumber Co. operation out of Omak, Wash., in a type very similar to ours, where brush-piling tractors had been in use for two or three seasons. The company was using D-4 caterpillar tractors with 60-inch center and 20-inch track shoe equipped with a specially constructed brush blade manufactured by the Isaacson Machine Works in Seattle, Wash. It was enthusiastic about the results obtained with these machines and was using them on its entire operation.

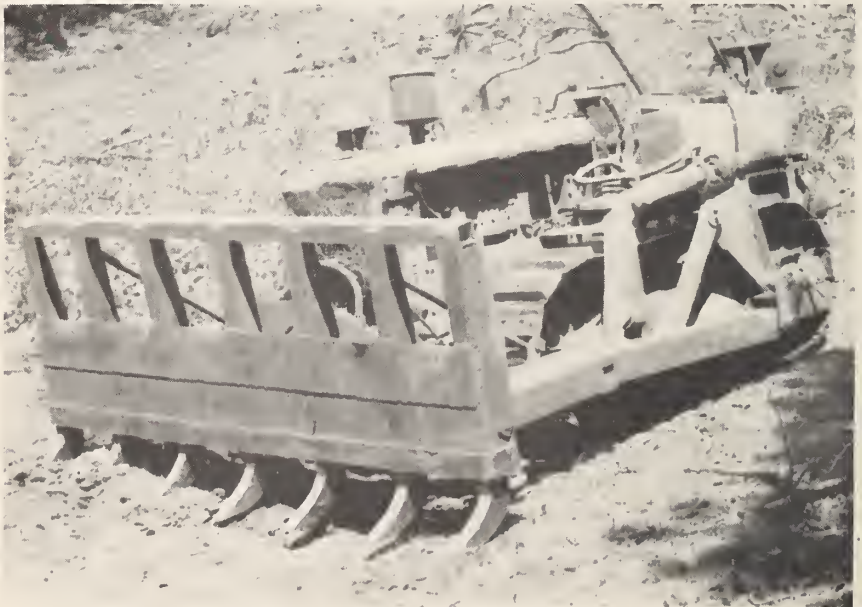
Our efforts to obtain machinery were redoubled and in October 1946 we acquired two D-4 caterpillar tractors through war surplus. These machines were in new condition but were narrow gage (44-inch center and 13-inch track shoe). They were equipped with La Plante-Choat hydraulic angle dozers and double drum LaTourneau winches with fair-leads. Because of the lateness of the season no slash-disposal work was done with these machines until the spring of 1947.

During the early spring, we had special blades manufactured to our specification by the Catlow Transport Co. at Spokane, Wash. These blades were built along the same general lines as the Isaacson blades but with several modifications. In the first place, the blades were made interchangeable with the angle dozer blades already on the machines. This was not the case with the Isaacson blade. Second, we extended the blade 10 inches on each end because of the narrowness of

the machine. This made the over-all width of the blade 109 inches instead of the 89 inches of the angle dozer blade. The change made little difference in the hook-up as the dozer arms readily move out an inch from the A-frame and the connections were moved in 9 inches from the ends of the blades. The original arms and A-frame were used. The blade was held in place by the same three pins which held the angle dozer. However, it was impossible to use the brush blade in any but the straight blade position. A secondary brace from the top of the brush blade to the back hole in the A-frame was tried but soon discarded as it was found to be superfluous. Slack in the hook-up also made it very hard to keep this brace from breaking.

The blade was equipped with seven detachable teeth that gave 11 inches vertical clearance and point forward 10 inches from the perpendicular. Above the teeth the blade was solid for 20 inches and was then a lattice-work affair to its over-all height of 50 inches. This open top was left for greater visibility for the operator and to reduce the weight of the blade, which even with this open work weighed approximately 300 pounds more than the angle dozer. One disadvantage of the changeable blade arrangement and the hydraulic dozer is that the blade is some 18 inches in the front of the machine because the A-frame is hung far enough ahead to clear the hydraulic pump. Another is the weakness of the hydraulic hoses in work of this kind. These disadvantages are offset by the speed of change to angle dozer for fire work and the ability of the hydraulic dozer to exert pressure down.

Work was started with one machine in June 1947, and one machine was kept in the field during the entire season or until mid-November. The limitations of the machine soon became apparent. Because of the narrow gage, it was unable to operate on slopes much over 20 percent. Rocky ground also stopped it. No attempt was made to oper-



A D-4 caterpillar tractor equipped with the 7-toothed brush blade.



The D-4 with the brush blade working in heavy slash.

ate in reproduction stands although some tops were winched out of these places. As the season progressed, we worked our hand piling and lopping crews closer to the machine and used the machine only where it worked most efficiently. During 1948 both machines were in the field from June until late October. Our greatest mechanical difficulty was the vulnerability of the oil return hose to the hydraulic pump. This was comparatively safe from brush in front but limbs and small stumps would get it from below and pull it off. Finally guards which extend under the pump and hoses were devised and bolted to the pump and radiator guards. This addition stopped our trouble.

We intend, but have not yet made, a second revision in the original blade. This will be to make the lattice work solid directly in front of the radiator in order to further protect the machine. This will not interfere with the visibility of the operator as he seldom looks directly over the front anyway, but should serve to protect the screen which must be used over the radiator to keep it from fouling up with moss and dust. Experience indicates that the added weight will make little difference, contrary to our original fears.

There are several advantages connected with handling brush with these machines. First, machine-made piles will burn much later than those made by hand because they are larger and tighter. Then, quite a percentage of the windfall and top that would normally be left on the ground gets into the pile. Not all this burns but the slash fuel is no longer around it to give a bad time in the fire season. In operating machines in piling, the ground is worked up, providing a better seedbed. While this is not vital, as it is already pretty well taken care of in present methods of "cat" logging, it still may be an advantage. During 1948 quite a bit of lopping was done with the

machines. This lopping was quite satisfactory where there was insufficient slash to make piles or where the debris was too scattered to make it pay to put it together in piles. Lastly, machine piling is much faster where it is possible and reduces the need for manpower, that has not been readily available during the past few years.

On the Southern Idaho Forest Protective District job, the machines are now used strictly as an integral part of the whole operation and always in connection with men for the outlying areas, the reproduction stands, and the steep or rocky places.

During the bad fire months, July, August, and early September, the machines are kept on jobs as centrally located as possible or as close as possible to our areas of high hazard. The angle dozer blades are kept on the job and the change from one blade to the other can be made by two men in 5 to 10 minutes. The machines are transported on a 6 by 6 International 2½- to 3-ton truck that is kept on the job during the summer months. In the course of the operation the machines are used to keep roads open to the jobs and so give freer access to slash areas at far less cost than that by hand or by hiring it done with contract machinery. As we have had two easy seasons since we started our machine project, we have used them only rarely on fire control but they are always ready and can be moved rapidly.

It is extremely difficult to estimate costs on an operation of this kind, but in areas on which we have done all the work with the machines, our costs for a 100-percent piling job have run from 20 cents to \$1 per 1,000 feet board measure depending on the site, the tractor operator, and the quality of the job done. When the machines are used in conjunction with a handlopping operation, the costs, of course, come down. It is our opinion, from 2 years' experience, that a 100-percent piling job can be done, with a good operator and on the type of terrain on which the machines can operate, for about half the cost of a hand job of the same quality.

The D-4 caterpillar tractor is a little small but we believe that the ease of transport and the speed with which it can be made ready for use on the fire line more than make up for this limitation. The operator must be efficient and must understand and take care of his machine as the work is extremely hard on machinery.

More protection for the machine and operator are needed, and the narrow gage on our machines materially limits the percentage of slope upon which we can operate. The machines, however, justify themselves on the slash-disposal operation alone, but at the same time they provide for fire control work a protection force which would not otherwise be available.

FOREST PROTECTION ADOPTS "BLITZ" METHODS

FRANCIS M. BURKE

Forest Area Supervisor, Wisconsin Conservation Department

With fire crews hard to recruit, rangers turned to mechanization. Now 2 or 3 men do the work of 50.

Forest fire suppression in Wisconsin just isn't what it used to be!

Prior to and during the early thirties, a fire call meant the forest ranger hustled his old "jalopy" from the garage, hastily threw on an armful of shovels, another of grub hoes or mattocks, a few back-pack water cans, and a jug of drinking water, slammed the door, and was off on his prearranged route to assemble his scattered fire crew of townspeople and settlers. Then off to the scene of the smoke as rapidly as the poor roads and trails of the day would permit.

In those days, persons residing in wild land areas expected to be—and usually were—called to assist the ranger when smoke from a forest fire rolled across the horizon. Manpower was available in considerable numbers and the economic conditions at the time were such that the low fire fighter wages were sought by many.

Upon arrival at the fire, the ranger unloaded his crew, distributed hand tools to each, and assigned them work at the burning edge of the running fire. Slowly and laboriously they proceeded to bring the fire under control. After the fire was knocked down, a control line at the outside edge was usually hand dug to mineral soil, thus confining the fire. Following this the crew worked at mop up on the burning interior by watering down burning stumps, logs, and other forest debris or covering them with cold, damp, mineral soil.

Delay in assembling a crew, the slow method of control, and the ever-present confusion when large numbers of persons are involved, all contributed to increased numbers of major fires.

As small fires became large, the services of more fire fighters were required. Greater numbers of supervisory personnel were needed to adequately apply the efforts of the fire fighters. Transportation to and from the fire as well as providing meals became costly and difficult to perform. Reconnaissance on the fire usually was accomplished by cruisers and scouts. Communication was handled by runners. Fire control practices and procedures of the day were the best possible but certainly not adequate to confine the many fires which occurred to small burned acreage.

The legal responsibility of a Wisconsin citizen to assist in forest fire suppression has not changed but the forest protection division of the conservation department is making every effort to minimize its need for large numbers of untrained, unskilled laborers for fire control purposes. The economic picture has changed so that it has become increasingly difficult to hire individuals at the low fire fighter wage when this means taking them from better pay employment.

The present-day trend is to hire small crews seasonally, locate them strategically near the hazard and high-risk areas, give them a complete short course in fire behavior and control practices, outfit them with equipment and machines especially designed to move rapidly to any fire area and quickly knock down and mop up all fires when they are small, send them back to their base to stand by for the next fire call.

To accomplish this "blitz" method of control we have late model trucks outfitted with tool boxes, water tanks, and power take-off pumps with which water may be applied to the fire edge from the truck tank supply. In addition we have small, narrow, crawler type tractors, readily maneuverable in wild land areas, which tow our middlebuster fire plows and thus rapidly establish control lines to mineral soil at the burning edge of the fire. Tractors also are equipped with water tanks and pumps so that the burning edge of a running fire may be cooled down with water at the same time control line plowing is done.



Three-man crew operating tractor with middlebuster plow and water-spray equipment.

Tractors and plows are easily and quickly loaded on tilt-bed trailers for over-the-road transportation by towing behind the larger trucks. Loading or unloading consumes but a matter of seconds.

In addition to the machines mentioned, we now use small tractors equipped with bulldozers, water-tank trailers capable of transporting large volumes of water to fire areas, small portable pumpers with fire hose lines to facilitate mop-up work, and FM radio to provide communications between field men and their headquarters or with other supervisory personnel on major fires.

For scouting and reconnaissance work and to aid in directing ground suppression forces, we employ a skilled observer in our airplane. The plane is radio equipped, making possible immediate and positive communication to field men below. With this arrangement, proper machines are assigned where most needed. The result is faster and better control.

We have recently received our first 4-wheel-drive power wagon trucks. These vehicles are capable of moving over terrain which heretofore has been inaccessible to other trucks. We believe that with these trucks we can offer speedier fire control to isolated areas and also when road conditions are poor. They will be outfitted with water tanks and take-off pumps so that a small crew may take suppression action on fires.

In every instance, we consider chiefly apparatus which can be efficiently operated by a small crew. Our tractor and plow units can each establish as much control line as 50 men using hand tools in the same time interval. Our blitz water tanker units can apply water to equal the efforts of 50 men using back-pack cans for knocking down the burning edge of a running fire.

It is not uncommon for a crew of two or three men to proceed to the scene of a fire as the initial attack crew, rapidly suppress the fire, and return to their station without employing any emergency assistance. Delays in collecting large numbers of workers are eliminated in this method of attack.

During the 1947 fire season, 54 of 239 fires in one of the 4 existing forest protection areas were suppressed entirely by ranger crews without the aid of hired labor. On the remaining 185 fires, a total of 624 men, or an average of 3.3 men per fire, were hired to assist in actual suppression work. On many of these fires, men were hired only to patrol the burn after the running fire had been stopped.

Our fire action plan schedules how apparatus, machines, and supervisory personnel will move to any major fire area. Equipment of the particular fire district will be called first and that in adjacent districts or from our Tomahawk headquarters will follow if needed. Within a short interval our airplane is available for aerial reconnaissance and observation work, and radio communication can be functioning to all parts of the fire.

This trend toward fighting forest fires with mechanical devices will not, in fact cannot, completely eliminate our future need for the services of emergency fire wardens, key cooperators, and numbers of fire fighters on major fires. Our suppression commitments are so widespread that machines will never be able to entirely replace our manpower needs.

Your Wisconsin forest fire control program is in the hands of a fast-charging, hard-hitting group of rangers and their aides. An occasional fire may become temporarily out of control and burn over an appreciable acreage of valuable forest growth but by far the most fires will be put out before the general public knows they exist.

THE RATE OF SPREAD—FUEL DENSITY RELATIONSHIP

W. S. DAVIS

Forester, Region 2, U. S. Forest Service

During a recent consideration of the value of fuel reduction as a fire control tool in the Rocky Mountain Region, a question was raised as to whether the density of fuel had any effect on the rate of spread of grass fires. The relationship between the rate of spread and factors such as wind, fuel moisture, relative humidity, and topography has of course been reasonably well established by earlier experiments; but no data could be found covering the problem in question. Casual observations of the behavior of prairie fires had created in some the belief that a fire would roll through sparse grass with the same velocity it attained in denser stands, although admittedly with a lesser intensity; whereas others held that a reduction in fire intensity would also lead to a slower rate of spread. To settle this interesting difference of opinion, it was decided to conduct some controlled burning on the Nebraska National Forest, where the rolling sand hill grasslands provide a good continuity of forage conditions.

Possibly the reason for the lack of data on the relationship between fuel density and the rate of fire spread lies in the fact that there is no convenient yardstick for measuring fuel density. In the Nebraska experiment it was decided to use the forage utilization of variously stocked range allotments as such a yardstick.

Two adjacent grazing allotments were then selected in gently rolling terrain. One showed an average forage utilization of 0.6 animal months per acre; the other was stocked only half as heavily. These two allotments were separated by a drift fence and a marked change in vegetation density was indicated on the fence line.

The forage consisted of a well-cured mixture of the following:

Turkeyfoot (sandhill bunchgrass)-----	<i>Andropogon hallii</i>
Dropseed-----	<i>Sporobolus</i> sp.
Prairie sandgrass (sand reed grass)-----	<i>Calamovilfa longifolia</i>
Lovegrass-----	<i>Eragrostis trichodes</i>
Sedge-----	<i>Carex</i> sp.
Hairy grama-----	<i>Bouteloua hirsuta</i>

Parallel plots, 500 feet in length and 100 feet wide, were established on each side of the fence and surrounded by adequate firebreaks.

The test was conducted in November. Some variance in temperature and relative humidity was noted, but the wind held at a steady 16 miles per hour throughout. The fires were allowed to run with the wind, and were set so that the lightly grazed and heavily grazed plots burned simultaneously, affording a good comparison. Stop-watch readings were taken on the rate of advance of the head of the fire in each plot. Since thermocouples were not available, the intensity of the fire was gaged by measuring the average height of the flames.



Portion of test area. Utilization: approximately 0.6 animal months per acre on left; approximately 0.3 animal months per acre on the right.

Finally, the fire was allowed to run with the wind from the lightly grazed to the heavily grazed area, in order to discover whether a rolling fire would be affected by thinner fuel.

All tests showed conclusively that the reduction of fuel density has a marked effect on both the rate of spread and the intensity of grass fires. Specifically, the average results were as follows:

Area:	Frontal advance of fire (feet per second)	Intensity of fire (average height of flames in feet)
Lightly grazed (0.3 animal months per acre)---	1.56	5
More heavily grazed (0.6 animal months per acre)-----	0.53	1

Under the test conditions, in other words, the residual density of grass as represented by a utilization of 0.3 animal months per acre will allow potential fires to advance three times as fast and with five times the intensity of fires in areas that have been grazed twice as heavily.

The result of the test is further proof that the principle of fuel reduction is sound, from a suppression standpoint. This finding of course, does not alter established Forest Service policy of managing the range primarily in accordance with the needs of the soil and vegetation rather than as a means of reducing fuel hazards.

THE SUMMERFIELD V-SCRAPER—A FIRE LINE BUILDER FOR OPEN PINE FOREST

J. A. EGAN

District Ranger, Coconino National Forest

On the Long Valley District of the Coconino there are 175 fires a year (10-year average). It is not unusual for a single storm to start 20 to 30 fires. Under these circumstances anything that will increase the efficiency of a fire guard is mighty valuable. The V-scraper, developed by General District Assistant Henry Summerfield, is just such a piece of equipment. Under ideal conditions a fireman with a combination fire tool can build about 10 chains of fire line per hour. Under the same conditions (anywhere that a pickup can go) the V-scraper behind a pickup with a four-speed transmission will build *2 miles of fire line per hour*.

When the fireman arrives at the fire he unloads the scraper, hooks it to his bumper or trailer hitch, throws on a few boulders or a dozen shovels of dirt, and starts around the fire making a 30-inch fire line as he goes. On rocky ground or where there is reproduction there will be a few skips in the fire line. One man with a combination fire tool can complete the line where the scraper skips—or if the fireman is alone he will have to stop occasionally and check the line to see that it is clean—down to mineral soil.



Bottom view of V-scraper, showing construction; and V-scraper in action.

Just how many fires, that might have become large, have been kept small by the V-scraper would be hard to guess; but it is safe to say that each year two or three potential class D fires have been kept down to B or C size and a dozen potential class B's remained as class A's. The savings on this one district can be estimated at several thousand dollars a year.

The few materials needed to build one of these scrapers are one used 6-foot grader blade, 4 feet of 1-inch angle iron, a 30-inch square of old roofing tin or galvanized iron, one $\frac{3}{8}$ - by 6-inch carriage bolt, nine $\frac{3}{8}$ - by 1-inch carriage bolts, 6 feet of $\frac{3}{16}$ - or $\frac{1}{4}$ -inch chain. Place the grader blade in a vice about 6 inches from the middle and heat the middle with an acetylene torch. Have a second man pull the end of the blade around to form a V with the ends about 30 inches apart. Holes can be drilled or burned in the angle iron (to fit the holes that are already in the grader blade) and punched in the tin. Attach the chain low inside the scraper so that it pulls over the top of the point of the V and keeps the front of the scraper in the ground.

The accompanying photograph of the bottom of the scraper gives enough details so that one can be built without difficulty.

Reverse Flow Fan for Fire Plow Tractors.—On the Francis Marion National Forest we have always been bothered with our fire plow tractors running hot because of radiators clogging up with debris. Dry pine needles, leaves, and grass are sucked against the front of the radiator despite any kind of supplemental screen that we have been able to devise. Air circulation through the radiator can be retarded enough after only 2 or 3 hours of plowing fire line to make the motor overheat, whenever the weather is warm and dry. It is hard work to clean trash out of a radiator, especially on the fire line.

Ranger John T. Koen wanted to try a reverse flow fan. A number of tractor operators and salesmen insisted that a reverse fan would not circulate enough air to keep the motor operating cool. Nevertheless, we bought one for an International TD-9 in March 1948 for \$5.60.

Although we have not had any fires on extremely hot and dry days since then to give it the "acid" test, we have used this tractor with reverse flow fan enough on prescribed burning to make us think we have solved our problem. The fan seems to push enough air through the radiator to keep it cool. The motor has not overheated. There is no clogging by debris on the radiator on the fan side. Whether the motor hood sides are on or off makes no apparent difference in air circulation or resulting heat of the motor.—C. S. HERRICK, JR., *Assistant Forest Supervisor, South Carolina National Forests.* (Reversed fans on tractors have also been used successfully in several instances in western regions.—Ed.)

VERTICAL WIND CURRENTS AND FIRE BEHAVIOR

JOHN S. CROSBY

*Forester, Lake States Forest Experiment Station*¹

Forest fires are known to behave in a variety of ways, sometimes in quite unexpected ways. Prompt suppression requires that the fire boss, in estimating the probabilities of control within the allowable period, consider factors affecting the behavior of the fire as well as those fixed by the site.

The important variables not determined by the specific location are the weather factors, primarily moisture and wind. Estimates of fuel moisture and winds are made on the basis of weather forecasts, or through a knowledge of normal daily variation and past experience based on observation of weather reactions in the locality. Often the weather forecast must be interpreted in terms of local topography, or proximity to large water bodies, so personal observation may be invaluable.

Although fuel moisture is an important factor, the purpose of this paper is to point out certain wind features, particularly those in which vertical currents are concerned, and to present a few general rules for recognizing the probability of their existence. On the ground, the best information available about wind is its surface velocity and direction, both of which may be constantly changing, whereas little if anything is known of the action of the wind above the immediate surface and which may have considerable effect on the fire.

Wind is air in motion. The direction of motion taken is almost unlimited. Near the ground the wind customarily blows in gusts and lulls, seldom as a steady even flow. Because it cannot be seen, it can only be noted by its effect on various objects, and hence it is difficult to obtain a complete picture of the variations that characterize air flow.

- Watching the drift of smoke is one way to observe its motion; this is like observing somewhat similar currents in a river. Both water and air are fluid, though water is more limited in its freedom of motion. The water swirls around and over rocks, makes eddies around land projections, and tumbles over falls. It exhibits motion in many directions besides down stream. Likewise, air moves in a turbulent fashion near the ground while still following a general course.

The general flow of air is determined by the air pressure gradient and is modified by the effect of the earth's rotation and the friction caused by the passage of the air over the earth's surface. The direction becomes clockwise around high pressure centers with a slight drift outward, and counterclockwise around low pressure centers with a slight drift towards lowest pressure. At any fixed location

¹ Maintained at the University farm, St. Paul 1, Minn., in cooperation with the University of Minnesota.

the wind direction changes as the pressure systems migrate and take up new positions in respect to that point.

Many reactions are superimposed on the flow of air, particularly near the ground, to modify the pressure flow. Aloft the wind is stronger, and more steady, being changed only by strong reactions.

Up and down air currents may exist in the lower atmosphere in a great variety of intensities and steepness of rise or fall. Small eddies in a light wind may be only a few feet in depth, whereas strong convection currents may extend several miles into the atmosphere, or the gentle lift caused by a warm front may amount to 10 feet in a mile, but extend over 1,000 miles.

At ground level the wind tends to parallel the surface; that is to say, because the wind cannot penetrate or go through the solid earth, its larger up and down currents must change to a motion along the surface on reaching the surface, though the direction may be variable, and small eddies still persist.

Sustained vertical motion of the air is more prominent at some distance above the surface where, of course, it is more difficult to observe. When a vertical motion, such as an eddy or convection current, is superimposed on the existing wind, the result is alternately to speed up and slow down the wind making it gusty and stronger.

The stronger the horizontal wind, the more turbulent it becomes in its passage over a rough surface, thus creating stronger eddies and more gustiness with frequent changes in direction. Turbulent, gusty winds affect fire behavior by fanning the fire in spurts from varying directions, and by carrying heat and embers to fresh fuels.

The motion of the air is also strongly affected by the heat it gains from the earth on sunny days. Air in contact with the ground then, because of the additional heat, becomes lighter than air above and tends to rise. The rising warm air sets up convection currents. A forest fire also sets up such currents locally because of the intense heating of the air by the fire.

The earth's surface is not uniformly heated. Water surfaces are cooler than land, and forested land cooler than exposed soil or rocks, so the surface air is not of uniform temperature. Warmed air tends to rise in streams usually localized over the warmer areas, or hills may help to start the warm air upward.

Down-drafts occur as complements to up-drafts. Both currents have their effect on a forest fire. While an up-draft in a favorable atmosphere has the effect of pulling on the rising smoke column, thus increasing the air feeding into the fire, the down-draft increases the surface wind velocity, making it more gusty and turbulent.

Once started, convection currents may be accentuated or depressed by the atmosphere, depending on its condition of stability. If stable conditions exist (where the temperature decrease with elevation in the atmosphere is slight) the convection currents will be damped. However, in relatively unstable air (where decrease of temperature with elevation is great) convection currents are increased in speed and depth. Convection currents sometimes rise to 8 or 10 miles in the atmosphere and develop great vertical velocities.

With night-time cooling, the air is stabilized at low levels, and the convection currents subside. This change is a part of the daily variation in stability. In flat country the wind then dies down. In

mountainous country the wind stops flowing up-slope and begins to flow down-slope. Along larger water bodies the daytime landward breeze changes at night to a seaward breeze. These changes are normal only when the pressure gradient is weak.

The stability of the air layers both near the surface and aloft greatly influences fire behavior. Very large fires generate intense heat and may enable the heated air to penetrate moderately stable layers and join or set up vertical currents aloft, thus giving a new impetus to the fire, causing it to flare up unexpectedly. A study of large fires in relation to air stability conditions aloft might throw new light on unexpected fire behavior, and provide a new tool for better forecasting fire behavior.

When there is marked air stability even during the daytime, the height to which convection currents may rise is of little consequence, and the diurnal variation in wind is not important. Thus, a strong daytime wind may not die down much at night because it is driven by the pressure gradient alone, and it will decrease only as the pressure gradient decreases.

These considerations are useful only insofar as one is able to plan for them and hence a few very general rules may be helpful.

While the actual stability of the air and the pressure gradient are basic, they are not subject to convenient observation at a fire. Indirectly, however, the condition of stability shows itself in several ways.

Cloud formations.—Cumulus type clouds are always an indication of rising air currents, and often indirectly of instability. In mountainous country, the rising currents may be due to lift over a ridge, while in level country it is almost always a result of convection if not associated with a front. For these clouds to form there must be sufficient water vapor present in the rising air so that it is cooled to its saturation point before the lift ceases. If the cloud bases are low it is an indication of abundant moisture; if high, water vapor is scarce. This condition is indicated at the ground surface by high or low relative humidity respectively. The height of the cloud tops indicate the height to which the convection currents extend, and show also the stability of the air as the currents do not penetrate stable air layers. Flat-topped cumulus clouds, therefore, indicate stability aloft.

Often, however, vertical currents exist without formation of cumulus clouds as the water vapor content is so low that it cannot be carried high enough to condense. Under such conditions, when the sky is mostly clear, evaporation is speeded, resulting in faster drying of fuels.

When relative humidity is low and temperature high, strong currents may exist to considerable elevations without clouds forming. A further check can be made by watching the rise of temperature during the morning. A sharp rise early that flattens out and remains high substantiates the prospect of deep vertical currents, assuming nearly clear skies. Small whirlwinds or dust devils also indicate unstable conditions, though they may exist only near the surface.

Thunderstorms and very large cumulus clouds indicate instability extending to great heights with strong vertical currents. Thunderstorms with high bases may be dry storms, that is, the rain evaporates into the air before it reaches the ground, and hence lightning strikes are more dangerous.

Stratiform clouds (fog-like clouds or layer clouds) indicate stable conditions at least at the level of the clouds though stratocumulus may often form in turbulent surface air even though the turbulence is shallow. In general, the lower the stratus clouds, if they persist, the more stable the air, and the less possibility of vertical currents. Low stratus clouds in the morning, however, often are a better indication of good moisture conditions than of continued stability during the day for they may have formed in a shallow layer of stable air that will rapidly change to an unstable layer during the heat of the day.

Visibility.—Good visibility is often a sign of unstable air in which vertical currents may develop. In unstable air the impurities are carried aloft and away, while stable air traps impurities and holds them in a shallow layer of air.

Air mass.—Cool air masses following cold fronts during the fire season east of the Rockies tend to rapidly develop instability in passing over warmer areas. This instability at first is not deep, but increases with time. The cool air is also dry air, and visibility is good. It is usually recognized as coming in with fresh northerly winds.

Winds.—Gusty winds with a noticeable decrease in velocity at evening indicate the possibility of strong convection currents during the day. Turbulence and gustiness are more readily started in unstable air. Such gusty winds usually are accompanied by frequent changes in direction. The direction may vary through 45 or more degrees rapidly, back and forth, or more moderately within periods of an hour or so.

HOUSING REMOTES FOR VHF RADIO

NORTH PACIFIC REGION

U. S. Forest Service

Postwar expansion in the use of radio in the North Pacific Region developed a need for inexpensive housing in which to mount radio equipment located remotely from its point of operation.

Most of our new radio equipment is in the very high frequency (VHF) range (30 to 40 megacycles) which is quite line-of-sight in its propagation. Many of the headquarters in which we wish to set up radios are down in holes or otherwise shielded by terrain so as to be ill suited to good transmission or reception of VHF signals. This difficulty may be overcome by setting up the radio antenna, transmitter, and receiver on a convenient high point and operating the station from the headquarters it serves over a pair of telephone wires.

Radio equipment of the kind used for headquarters stations usually comes in a vertical floor mounted cabinet about 24 by 24 by 74 inches with doors for servicing on both front and back. We decided that the housing need be no more than is necessary to protect this equipment adequately from the weather and vandalism. We also required that the housing be semiportable for ease of installation and to comply with regulations governing installations on leased or other nongovernment land. The building also had to be cheap and require a minimum of maintenance.

Out of these specifications our shop personnel and radio engineer developed a welded steel building approximately 3 by 3 by 6½ feet with arched roof and with doors on two sides opposite the doors of the radio cabinet which it houses. One-quarter inch steel plate is used for the bottom, arched roof, and two sides of the building. The remaining two sides are composed largely of watertight steel doors salvaged from the deck houses of scrapped ships. Air inlets are provided low down in the two sides and a thermostatically controlled exhaust fan mounted in the overhead. A receptacle for receiving the 1½-inch pipe that supports the antenna is welded onto the roof. Angle iron flanges are welded to the bottom and drilled to receive hold-down bolts for mounting on a concrete slab or other convenient foundation.

The entire structure weighs about 1,100 pounds and can be carried in the back of a pickup truck. Utilizing the ships' doors at junk prices of \$7.50 each, the houses cost \$242 complete with exhaust fan, thermostat, and 18 feet of 1½-inch pipe for antenna support. They could be fabricated by any small welding and metal shop at that price if convenient to a shipyard wrecking area where the doors can be obtained.

HAULING CONSTRUCTION MATERIALS FOR LOOKOUT TOWERS BY HELICOPTER

MASON B. BRUCE, *Assistant Supervisor*, and CARL H. CRAWFORD,
Forest Engineer, White Mountain National Forest

The White Mountain National Forest had the problem of transporting some 26,000 pounds of building materials and equipment to a new tower location on Mount Pequawket (elevation 3,268 feet) near Conway, N. H. The job involved building a $3\frac{1}{2}$ -mile tractor road to within a half mile of the summit and then back-packing the materials from there to the top, the summit of Pequawket being so ledgy as to make the use of horses or tractors impractical. Lack of cover and high winds keep the snow pretty well blown from the ledges and make the use of a snow road to the top out of the question. After careful study, it was estimated that the transportation job could be done for \$3,033.

It was decided to investigate the possibility of hauling the materials to the summit by helicopter. The difference in elevation between the nearest roadside clearing and the point of delivery was 2,500 feet; airline distance was $2\frac{1}{4}$ miles. The material to be hauled varied in nature from treated timbers 2 inches by 10 inches by 20 feet, to metal window casings measuring about 3 by 4 feet, and bulky cartons of insulating bats measuring some 2 by 4 by 4 feet. A quantity of sand and cement was also included.

Bids were solicited from all known helicopter owners in the New England area. New England Helicopter Service, Inc., of Hills Grove, R. I., agreed to do the job at a uniform rate of 9 cents per pound, which brought the cost of transportation to \$2,372.49 for 26,361 pounds. Loading and unloading were done by Forest Service personnel under the direction of the pilot.

Two helicopters were used, Bell models 47B (1947) and 47D (1948). Each was equipped with two tubular aluminum crosspieces attached to the landing-gear supports. Lumber and other long and bulky material were secured firmly to these cross members. Items smaller in over-all size were carried in the cab. There was no significant difference in the results obtained from the two models used.

A small field, less than a quarter of an acre in size, was ample for a landing point. For a landing point on the top of the mountain, it was necessary to level off an area roughly 25 feet square with small stones and dirt. The particular helicopters being used had no wheel brakes and could not land on sloping surfaces. No clearing of trees or brush was necessary since the mountaintop was barren.

Loads varied from 250 to 425 pounds, depending upon temperature and wind. Carrying capacity increases as temperature drops, and winds up to 40 miles per hour have a definite favorable effect. Average loads, exclusive of pilot, were 300 pounds. A loading crew of two men



Loading crew in operation. Lumber was secured with straps; small materials were carried inside.

at the foot of the mountain sorted, weighed, and bundled the materials. An unloading crew of two men at the top detached the loads and stored them. These were the minimum size crews necessary at each point. At times, they were hard pressed to keep up with the flow of materials.



Helicopter taking off with full load.

During the best day of operation, an 8½-hour day, 13,000 pounds were carried by the Model 47D. Round trips, including loading and unloading, averaged about 12 minutes each. Several individual loads were completed in as little as 8 minutes each. Extra help was necessary in loading and unloading during this day.

Some unusual cost was involved by the New England Helicopter Service, Inc. The carrying cross members were fabricated for this particular job and experimental expense was entailed in their development. The Helicopter Service had to carry on rather time-consuming negotiations and tests with the C. A. A. and their insurance company before permission could be obtained to go ahead with the operation.

Officials of the Helicopter Service reported the operation to be a practical one and indicated active interest in bidding upon similar jobs. This was the first operation the concern had attempted in mountainous country.

The results of the project indicate that helicopters are practical for transporting certain types of construction material and equipment to points made inaccessible by elevation and lack of roads. Their use should be given serious consideration in planning transportation to such locations.

Aerial Fire Detection.—During the last week in August and the first week of September 1948, a series of dry lightning storms occurred on the Poudre District of the Roosevelt National Forest in Colorado. Five fires, the forerunners of 12 in a 6-day period, had been started. These had been located by lookouts or by local people and were in all stages of being suppressed.

On August 31 the lookout on West White Pine Mountain spotted what he thought was a smoke in the vicinity of Crystal Mountain. Local ranchers were immediately dispatched to the area but could not locate the fire. On September 1, I hired a plane from a local air service company to fly over the area in an endeavor to locate the lost fire. Upon approaching the locality where the smoke had been seen, we ran into another dry lightning storm. The air became exceedingly rough and we were forced to climb to an altitude of 13,500 feet.

While we were flying at this altitude, in the Luscombe two-place plane, a bolt of lightning seemed to flash past, and almost immediately we saw a large ball of white smoke puff up from a ridge top south of Crystal Mountain. Immediately following this smoke a tree burst into flame. The plane was not equipped with a radio so upon determining the exact location of the strike, we headed for the airport near Fort Collins. Thirteen minutes after the strike had occurred it was reported to the supervisor's office and suppression action was immediately started. The fire was held to an area of approximately 50 square feet.

The area in which the strike occurred was only indirectly visible from the nearest lookout tower 6 miles distant, and the lookout failed to see the smoke until long after suppression action was started. The use of a plane in this case quite likely prevented the fire from developing into a much larger one, since fire danger was high.

In areas where a regular air detection system is not set up or justified, a short patrol after each dry lightning storm may well be worth the cost.—Howard W. STAGELMAN, *Forester, Roosevelt National Forest.*

MOBILE REFERENCE MAP

ED. J. SMITHBURG

District Ranger, Los Padres National Forest

Need for a readily accessible map for reference when learning a new district led to the use of a map mounted on a window blind above the windshield on a pickup. The arrangement proved so handy that the writer has used one for about 8 years, transferring it from car to car, and putting on new maps when changes of station made it necessary. Time saved at intersections has been considerable, and the map has proved of value for follow-up dispatching while enroute to a fire.

The cost of the blind is negligible; installation is easy, but must differ slightly for each type of vehicle. The regular brackets furnished with the blind work very well. It is usually possible to use two of the machine screws holding the windshield channel to hold the forward edge, and a couple of metal screws to hold the rear edge of the brackets. When the blind is in place it is well to squeeze the bracket together so the blind won't jump out. Leave the stick at the bottom of the blind longer, so the blind can't accidentally unroll and spin. Gluing the map to the blind is not necessary. To install the map on the blind, unroll both, place the map on top of the blind and



roll snugly together. Fasten the bottom edge with scotch tape and staples, then unroll and fasten the top similarly. • Do not fasten the sides. Tension when pulling the map down keeps the map smooth and straight, and the blind prevents the light from shining through.

We plan this year to equip all tankers with water maps showing the location of all water supply sources, together with the amount, and method of drawing water. All routes of travel will be shown, including accessible ridge tops. All patrolmen will be equipped with human use maps showing points of public contacts and types of hazards present.

Accident Experience of Smoke Jumpers, Region 1, 1948.—Clyde Blake, safety officer for Region 1, reports that 142 jumpers completed training and 758 jumps were made, 580 training, 164 on 41 fires, and 14 on rescue mission. Only 3 disabling injuries occurred. Two of these, a sprained foot and a sprained back, were the results of hard parachute landings; the third, a broken leg in a felling accident.

Accident Experience of Smoke Jumpers, Region 4, 1948.—A report of the accident experience of smoke jumpers at 2 bases, McCall and Boise, revealed that in 500 jumps by 63 jumpers only 3 accidents occurred. Two of these were minor jumping accidents involving no lost time that occurred during training jumps. The third, resulting in broken bones, happened during a jump to a fire and caused a loss of 144 man-days. Statistics were given for age groups as follows:

Age:	Jumpers	Jumps	Accidents
24 and under.....	47	403	3
25-29.....	13	80	0
30-34.....	2	10	0
35 and over.....	1	7	0

One of the minor accidents occurred to a jumper weighing less than 150 pounds; the other two, to jumpers weighing more than 150 pounds. At the McCall base there were also nine minor accidents such as ax and saw cuts and bruises. Two of these occurred in fire suppression work, the others on project work.

Safer Single Edge Brush Hooks.—Marvin D. Hoover of the Southeastern Forest Experiment Station, in a good suggestion on single edge brush hooks says, "Very little or no cutting can be done with the extreme point of the blade or the heel, and these edges become very sharp with repeated filing of the blade. At the same time these are the parts of a blade most likely to cut men. We have dulled about one-half inch back from the point and rounded and dulled the heel.

"In actual use the workers found no objection to this change and we all believe it is much safer."

The Forest Service specification for single edge brush hook, revised in 1947, includes this safety provision.

STRIP MAP FOR USE IN OBSERVATION PLANE

T. A. PETTIGREW

Control Dispatcher, Trinity National Forest

For 3 years the Trinity Forest has been using strip maps in plane observation while scouting fires, etc. They are prepared from $\frac{1}{2}$ -inch scale forest maps and have been found convenient and serviceable. The instructions for cutting, folding, and mounting should be followed step by step.

1. Mark off map vertically into three strips with the center strip 1 inch wider than the combined widths of the outside strips. The outside strips should be same size. Make these marks solid lines, as they will be cut later; number the lines 1 and 2 as on the accompanying drawing.

2. Draw three vertical broken lines through the center section dividing it into fourths, number lines 3, 4, and 5; later the map will be folded on the broken lines.

3. Draw a vertical broken line through each of the outside strips, one-fourth inch off center toward the outside of the map. These lines will be numbered 6 and 7. This operation completes the vertical division of the map.

4. Measure the distance from the first horizontal line above the range numbers at the bottom of the map to the top of the map and divide into three equal sections by drawing two solid horizontal lines between vertical lines 1 and 2 and from lines 6 and 7 to the edges of the map. Complete these lines by drawing broken lines from vertical lines 6 to 1 and 2 to 7. These lines are numbered 8 and 9.

5. The map will be cut into nine sections so at this time letter the sections; the cuts will be made on lines 1, 2, 8, 9. Starting at the upper left corner letter the sections A through I.

6. Divide each of the first two horizontal tiers of sections, A, B, C and D, E, F, with a broken horizontal line in the center of the sections. Number these lines 10 and 11.

7. Draw a broken horizontal line through the bottom tier of sections, G, H, I, halfway between the line above the range numbers and the top of the section. This is line number 12. This completes the marking of the map.

8. Cut the map on vertical lines 1 and 2.

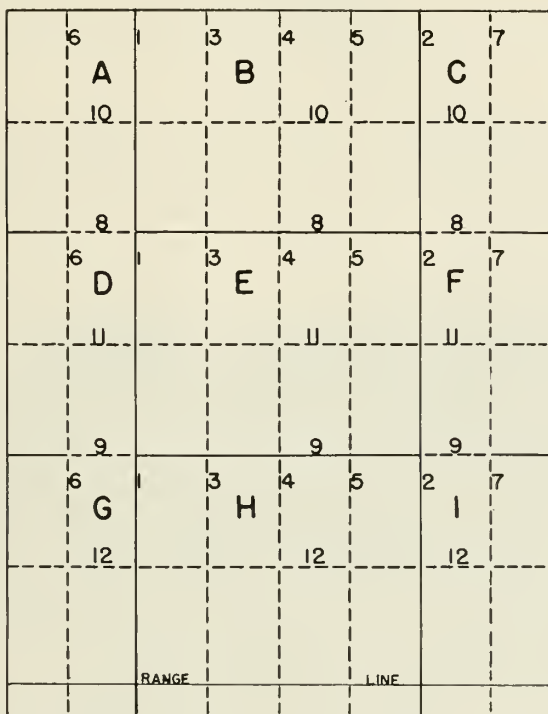
9. Remove the center strip of the map; slide the two outside pieces together and join by using a strip of 1-inch linen tape on the back of the map.

10. With the face of the map up, fold the edges of the map up on lines 6 and 7.

11. Cut the solid portions of lines 8 and 9 on the two outside strips and also on the center strip.

12. Take the outside strips which have been fastened together and fold up on lines 10, 11, and 12, and fold back on lines 8 and 9.

13. Using a manila folder for a cover, open the folder and place the outside strips with horizontal line 10 on the fold of the manila folder. Take four pieces of 1-inch linen tape, 7 inches long, fold them $2\frac{1}{2}$ inches from the end, and stick the glued sides together. This is done to prevent this part of the tape from sticking later. Fasten the exposed glued edges to the back of the map between lines 6 and 7. Make sure line 10 is parallel to the fold of the cover and staple the top end of the four pieces of linen tape to the folder.



Method of marking, cutting, and folding map in preparing strip map; cut on solid lines, fold on broken lines.

14. Place line 12 of the outside strips over the fold in the folder and staple the bottom edge of the map between lines 6 and 7 to the folder.

15. Fold the bottom sections of map attached to the folder to expose sections A and C. Unfold these sections to their full width.

16. Take section B and with it folded up on line 4 lay this fold on the joint of lines 1 and 2 and fasten it in place with a strip of transparent scotch tape along the entire length of the joined edge. Now fold this section to the other side and run a strip of tape on as before.

17. Now fold the edges of sections A, B, and C up on lines 6 and 7 and back on lines 3 and 5 and open at line 4. Now fold up on line 10 to expose sections D and F.

18. Insert section E using the same method as applied for section B.

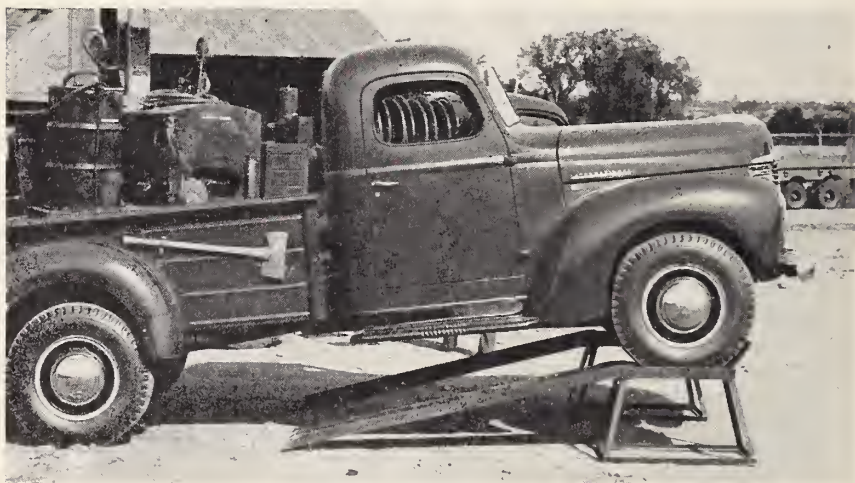
19. Fold up on line 11 and insert section H. Fold up on line 12 and this completes the operation.

FIELD EMERGENCY SERVICE RAMPS FOR VEHICLES

L. K. GARDNER

Inspector of Engineering Equipment and Materials, Region 5, U. S. Forest Service

In fire camps and other temporary work camps, it is difficult to properly service those types of vehicles, such as sedans and pickups, which have limited ground clearance. The serviceman is forced to work at complete disadvantage and the quality of service performed is expectedly inadequate. To facilitate the lubricating of vehicles Region 5 has developed portable service ramps.

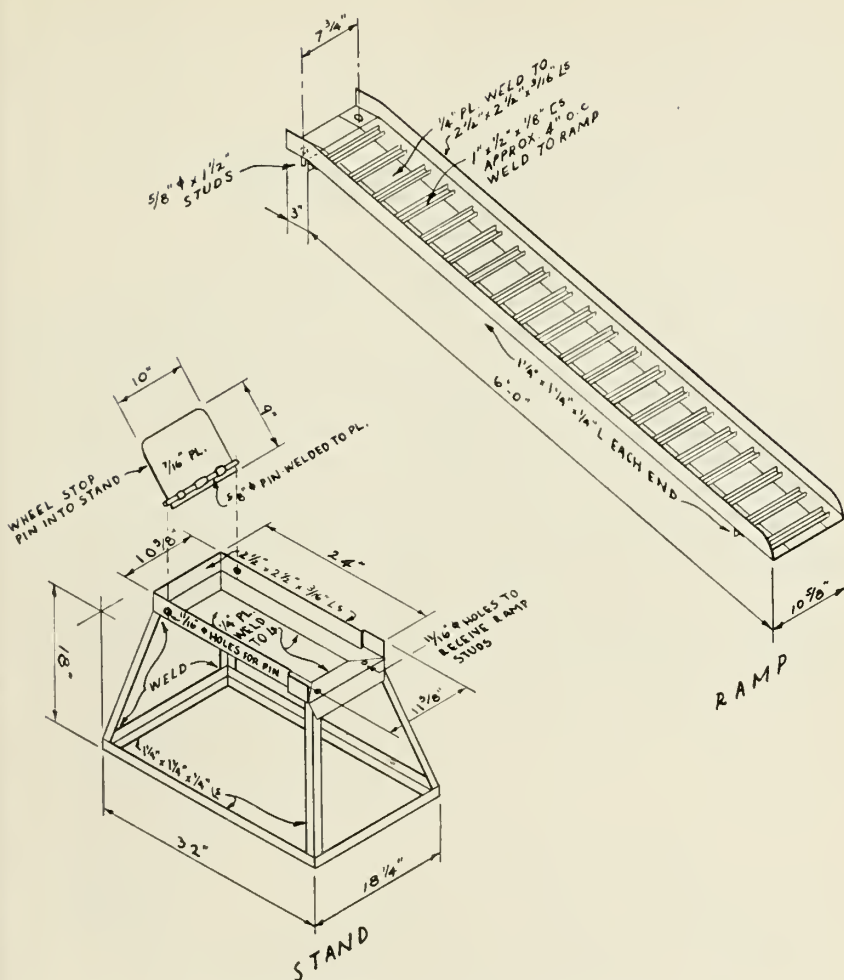


Ramp and stand in use.

These ramps, upon which one end of the vehicle can be driven, will provide adequate ground clearance. Raising one end of the vehicle 18 inches permits freedom of movement and greater accessibility to all the under parts.

In use, the ramps are set up in the most suitable location, preferably level, hard ground, and spaced in accordance with the tread width of the vehicle. Either end of the vehicle can then be run upon them. Wheel stops prevent overrun and wide bases of the stands afford stability to prevent overbalance or upset. After one end of the vehicle is in position on the stands, the incline ramp can be temporarily removed to permit increased accessibility.

As a safety precaution, placement of blocks under the wheels on the ground is recommended to prevent possible rolling of the vehicle.



Portable emergency service ramp and stand.

The ramps are made in pairs, each consisting of a substantial stand and detachable incline ramp, forming a compact unit during transportation when not in use. Although purposely designed of light materials for portability, structural strength is adequate and safe for all ordinary purposes up to and including the front end of an unloaded 1 1/2-ton stakeside. No attempt has been made in the design to accommodate dual wheels. The rear portion of a truck has sufficient clearance and exposure of parts to present no problem of accessibility.

In most instances, the ramps are set up alongside a luber unit. Service of a concentration of vehicles can be greatly facilitated with such a combination.

The ramps were originally devised for lubrication purposes, but it has been found that considerable advantage is offered for repair purposes, or for any reason the extra clearance is desired.

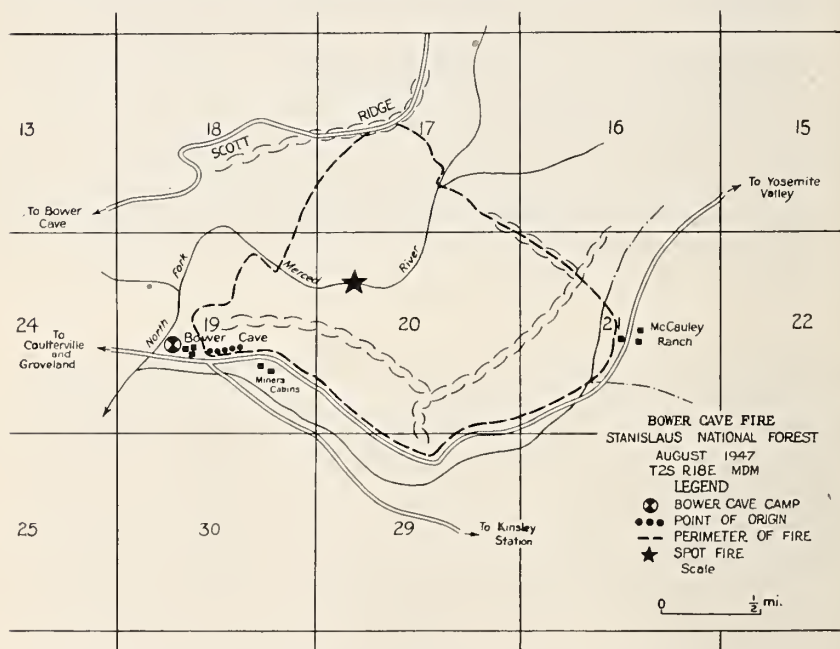
THE BOWER CAVE FIRE

LEON R. THOMAS

Fire Control Officer, Sequoia National Forest

The Bower Cave Fire of August 13, 1947, on the Tuolumne District of the Stanislaus National Forest is being reviewed to show how a fast-moving fire, which was burning in steep terrain and in heavy cover, was readily and quickly controlled, after the first attack had failed, by effective use of modern equipment, and by the local people and trained Forest Service personnel working effectively as a team.

August is a most dangerous fire month in this area. The weather is normally hot, fuel moisture is low, and rapid spread of fires can always be expected. At the time of this fire normal weather conditions prevailed throughout the district and no important changes were forecast. It is estimated that there was an up-slope wind of 8 miles per hour blowing at the fire when the first crews arrived. It increased in velocity during the day but never blew hard. There is a normal downdraft at night with increase in humidity.



Map of Bower Cave Fire, Stanislaus National Forest, Calif.

Bower Cave, a former resort, is located near the old Coulterville-Yosemite road where the road crosses the North Fork of the Merced River. The ridge between Bower Cave and McCauley ranch and Scott Ridge to the north of the river have moderate to steep slopes and are covered with scattered ponderosa pine and black oak with a heavy ground cover of manzanita and scrub oak. Elevation ranged from 2,350 feet at Bower Cave to 3,400 at the higher reaches of the fire perimeter. The sets were on a grassy, pine-oak flat with the steeper slopes and heavier cover just to the north.

For many years there has been an incendiary problem on this part of the ranger district. Sets are always in high hazard types; and several severe fires have been the result. This fire appeared to be another of that type.

The first report was received in the district ranger's office at 9:25 a. m. August 13, 1947. The ranger, fire control assistant, and the district clerk-dispatcher were in the office when the report was phoned in by the caretaker at Bower Cave. He reported that there were several small fires burning on the upper side of the McCauley road between Bower Cave and the miners' cabins one-half mile up the road. The area is blind to all lookouts and not until 9:40 a. m. did the lookout on Pilot Peak report smoke coming up over the ridge that blanked out the area for him.

The Kinsley Station crew, being the nearest organized fire suppression crew, consisting that day of two men and a light pickup tanker, was immediately dispatched. They arrived at the fire at 9:48 a. m. The fire control assistant and one fireman arrived at 9:56 a. m.

The ranger station crew of two men and a tanker was dispatched as was the third organized fire crew on the district, the McDiarmid Station crew of four men and a tanker.

The district ranger helped the clerk notify the central dispatcher and a few local people and was at the fire by 10:05 a. m. with a radio-equipped pickup.

The Kinsley crew found five separate fires burning on the upper side of the road within a distance of about 100 yards. Two Pacific Gas & Electric Co. power line construction employees, who had seen the smoke while working on a nearby line, were already putting a line around the fire nearest Bower Cave. These two men corralled this fire, the smallest of the five, at about one-tenth of an acre in size. The Kinsley foreman left his one man on the second fire and attempted to handle the other three alone with the aid of the light tanker. These three fires were the largest of the five and were rapidly burning together. They were burning in the grass and pine needles and were working toward the steep slope above.

Little, effective control work had been accomplished on the upper four fires when the fire control assistant arrived at 9:56 a. m. He and the one man with him joined the Kinsley foreman in attempting to cut off the head of the main fire at the toe of the steep slope. The Bower Cave caretaker had also arrived and was assisting the foreman.

The fire was burning very hot and was spotting badly up the steep slope when the ranger arrived at 10:05 a. m. He fell in with the other men in attempting to cut off the head and control the spots. The fires which had now burned into one were just too hot to handle and the light tanker was ineffective.

By 10:15 a. m. it was fully realized that the initial attack had failed. The heavier tankers from the ranger station and the McDiarmid Station did not arrive until too late to be of value on initial attack.

The ranger and the fire control assistant made plans for and immediately started a flanking action to keep the fire narrow and possibly pinch it out on the ridge above, should sufficient help arrive soon enough. There was a very good possibility of control on top of the ridge above Bower Cave since once the fire reached the top it would have to burn along the ridge or downhill for a considerable distance. The cover was also lighter along the ridge and on the north slope.

The dispatcher was notified of the situation by radio and a request was sent in to the supervisor's office to have the fire and the area scouted from the air. Orders were sent in to get all the help possible from the local sawmills, woods crews, Pacific Gas & Electric Co. construction crew, and the local ranchers. Two 15-man district road construction crews and a 50-man district blister rust crew were also ordered. A fire camp was to be set up at Bower Cave. It was calculated that this number of men could corral and hold the fire on the ridge that afternoon with an estimated area of about 200 acres. After 10 a. m. the men began to arrive rapidly, as indicated by the number on the fire in the following tabulation:

Time:	<i>Men on the fire</i>		
	<i>Local labor</i>	<i>Forest Service personnel</i>	<i>Cumulative total</i>
9:25 a. m.-----	0	0	0
9:30-----	2	0	2
9:48-----	1	2	5
9:56-----	0	2	7
10:05-----	0	2	9
11:00-----	81	40	130
12:00-----	21	0	151

The forest fire control officer flew the fire at 11:15 a. m. in a conventional aircraft and reported to the ground by radio that the flanking action was making good progress and that it had a very good chance for success by the early afternoon.

At 12 noon the ranger and a local rancher scouted the ridge in front of the fire and kept in communication with an SX radio. At 12:16 p. m. the lookout on Pilot Peak reported a smoke in the bottom of the Merced River about one-half mile to the northeast of the original fire. In a few minutes the ranger could see the smoke from his position on the ridge. It appeared to be burning on both sides of the canyon and spreading toward Scott Ridge and the McCauley ranch as well as back toward the original fire.

The forest fire control officer again scouted the fire from the air at 2 p. m. The ranger in the meantime had gone around and scouted the new fire from the Scott Ridge side. Through radio discussion with the fire control officer in the plane and with the ground scouting information, it was determined that the fires would burn together before they could be controlled. It was then decided that both fires should be handled as one.

The cause of the spot fire was not determined. It may have been another set. No attempt was made to send men to it as it was spread-

ing rapidly when first discovered and an initial action crew would have been ineffective.

It was realized now that control lines would embrace an area of a thousand acres or more and that a good deal of the line on Scott Ridge and the McCauley area was a bulldozer show. Additional tractors were ordered. Two D-7 caterpillars were walked to the McCauley ranch from a nearby Forest Service road construction job. One D-7 caterpillar was trucked in from another Forest Service road job on the district and a TD-14, the Forest Service fire stand-by tractor, was trucked in from the supervisor's headquarters. Two bulldozers were already on the fire, a D-6 from a nearby gold dredge and an AC tractor from a nearby sawmill. These last two arrived early but were of little use on the original fire.

All effort was now turned toward handling the two fires as one along the following plan: The hand line that had been constructed along the west side of the fire above Bower Cave was to be dropped in to the river to the north and held. The front of the fire on Scott Ridge was to be headed and a line dropped to the river along each flank. The line on the west side was to tie to the hand line at the river. Each of the lines from Scott Ridge was a bulldozer show until they reached the steep river slope. A line was to be built from McCauley's over the ridge to the north and then to the river and tie to the east line from Scott Ridge. The road from the McCauley ranch to Bower Cave was to be backfired. Four of the bulldozers were walked to Scott Ridge where two were to work on each of the lines from Scott Ridge to the river. Two tractors were to operate from McCauley's.

The camp was now in full swing and all incoming men were organized into crews with sufficient Forest Service overhead for good management.

The fire control officer and the forest supervisor came into the camp at about 4 p. m. With the aid of scouting information and aerial photos the final control routes were determined. The fire was divided into four divisions and the division overhead personnel were briefed on the construction and the backfiring plan. By 6 p. m. all crews, tractors, and other equipment were on the line and prepared for a night operation.

The plan went according to schedule and the night work was so efficient that by midnight most of the lines had been built and burned out. Many of the dangerous snags were felled by power-saw crews before the backfires were started. This was an important factor in reducing the possibility of spot fires as well as cutting down mop-up and patrol work later. The fire was declared to be under control by 9 a. m.

A look at the available Forest Service manpower in the early evening indicated that there was not enough for the mop-up job the next day. Needs were calculated and an order was placed for one division team from another forest and 150 off-forest laborers. The division team was flown in from the Sequoia Forest and the 150 laborers were picked up at Stockton in the San Joaquin Valley. All were at camp in time for the next day's shift. The Sequoia team did an excellent job on a division unit and returned to their home forest after one shift.

Mop-up proceeded rapidly during the early morning and the next day with tractors widening lines, with tankers working along the bulldozer lines and the roads, and with power saws felling the remaining snags. Especially important on mop-up was a 4 by 4 blister rust spray rig. This four-wheel-drive unit with its long light hoses reached many places that were inaccessible to the conventional tankers.

Two Pacific marine portable pumpers and hose were taken into the river on the east side of the fire by pack horses and were used very effectively on mop-up on the river slopes. The fire boss was equipped with a jeep and a portable radio during the mop-up period. He was able to cover all of the fire lines in the jeep except the steep river slopes. The fire was declared to be officially out on August 23.

There were many factors working together that contributed to the control of the fire prior to the burning period of the second day. The most outstanding ones are listed in the following paragraphs.

The early and efficient dispatching of personnel and equipment by the district and the central dispatcher was an important factor. Men and materials were ready to go. Sufficient experienced Forest Service and local men were readily available. Exceptionally good cooperation was received from the local people—labor from the sawmills, woods crews with power-felling equipment, electric power line construction employees, and experienced local ranchers. There were 210 men on the line during the night shift and 272 on the line during the next day. Men were released rapidly after the end of the second day's shift.

The effectiveness of the work during the first night was an outstanding factor in the early control of the fire. Control could not have been effected by 9 a. m. the following morning, however, even with the manpower available had it not been for the efficient work of the tractor operators in the heavy manzanita cover. Lights on the six tractors enabled them to work all night. Wide effective lines were the result. Total perimeter of the fire was 598 chains handled as the following tabulation shows:

Type of line:	Line constructed (chains)	Line backfired (chains)
Hand.....	160	50
Tractor.....	200	200
Road.....	238	238

Excellent radio communication during the entire fire made administration fairly easy. The radio net centered around the Pilot Peak lookout who used a T set for receiving and relaying messages. Division bosses were equipped with portable SX sets. A mobile unit and then an SX set were used by the fire boss. A mobile set was used in the fire camp.

A telephone connection was made to a nearby line and run to the fire camp. This took a load off the radio net.

The use of aerial scouting and aerial photos for plotting the fire and the control line aided greatly in early control. This combined with limited ground scouting proved very effective.

The camp was well located near the fire and was rapidly put in full operation by experienced personnel. Lunches, lights, water, and other equipment were always ready to go before departure time scheduled for crews. Adequate transportation was available and ably coordinated under the camp boss.

This fire, burning in steep heavily covered terrain, was readily controlled before the second burning period at 1.223 acres because of the effective use of modern fire fighting equipment, the excellent co-operation of local people; and the efficient work of Forest Service personnel.

Fire Camp Food Order.—On large fires, service chiefs, camp bosses, and supply officers transmit long food order messages that tie up telephone lines or radio channels for some time. These food orders often interfere with radio or telephone communication on the fire line that is of first importance. We have devised a method of transmitting food order messages that has proved to be accurate and considerably faster than heretofore.

When the fire boss determines that he will need a fire camp set up our practice is to dispatch a 100-man camp outfit which includes food for 100 men for three meals. From that time on the camp boss orders food according to what he has on hand and what he needs. He uses a food order list on which each food item is given a number. The camp boss lists the quantity of food needed and turns the list over to a telephone or radio operator. The operator transmits the requisition by calling off the item number followed by the quantity desired. Thus there is no need to use the item name. For example: "Fifteen forty" means "forty pounds of sausage." Here two words replace four.

The form is letter size. Its heading and some of the items of food are shown below:

FIRE CAMP GROCERY ORDER

Order received _____ A. M. _____ Fire Camp
Time out _____ Received by: _____
Truck No. _____

1. _____ lbs. bacon	80. _____ btl. catsup
2. _____ lbs. butter	89. _____ oz. pepper
15. _____ lbs. sausage	105. _____ ctus. matches
28. _____ boxes apples	114. _____ boxes soda
72. _____ lbs. rice	116. _____ ctus. towels, paper

¹ In addition to the saving in words the list eliminates all writing by the receiving officer except that of merely entering the quantity figure in the appropriate space. This elimination of pencil work speeds up receipt of the message and makes for greater accuracy.

Items 1 through 40 are all fresh or perishable items and are listed together to simplify ordering from merchants or loading from the walk-in refrigerator.

This list also serves the cook and camp boss as a check against overlooking items needed.

A supply of the forms is provided forest officers who may be concerned with ordering food and a quantity is placed in camp boss boxes at the beginning of each fire season.—ALVIN EDWARDS, *Storekeeper, Mendocino National Forest.*

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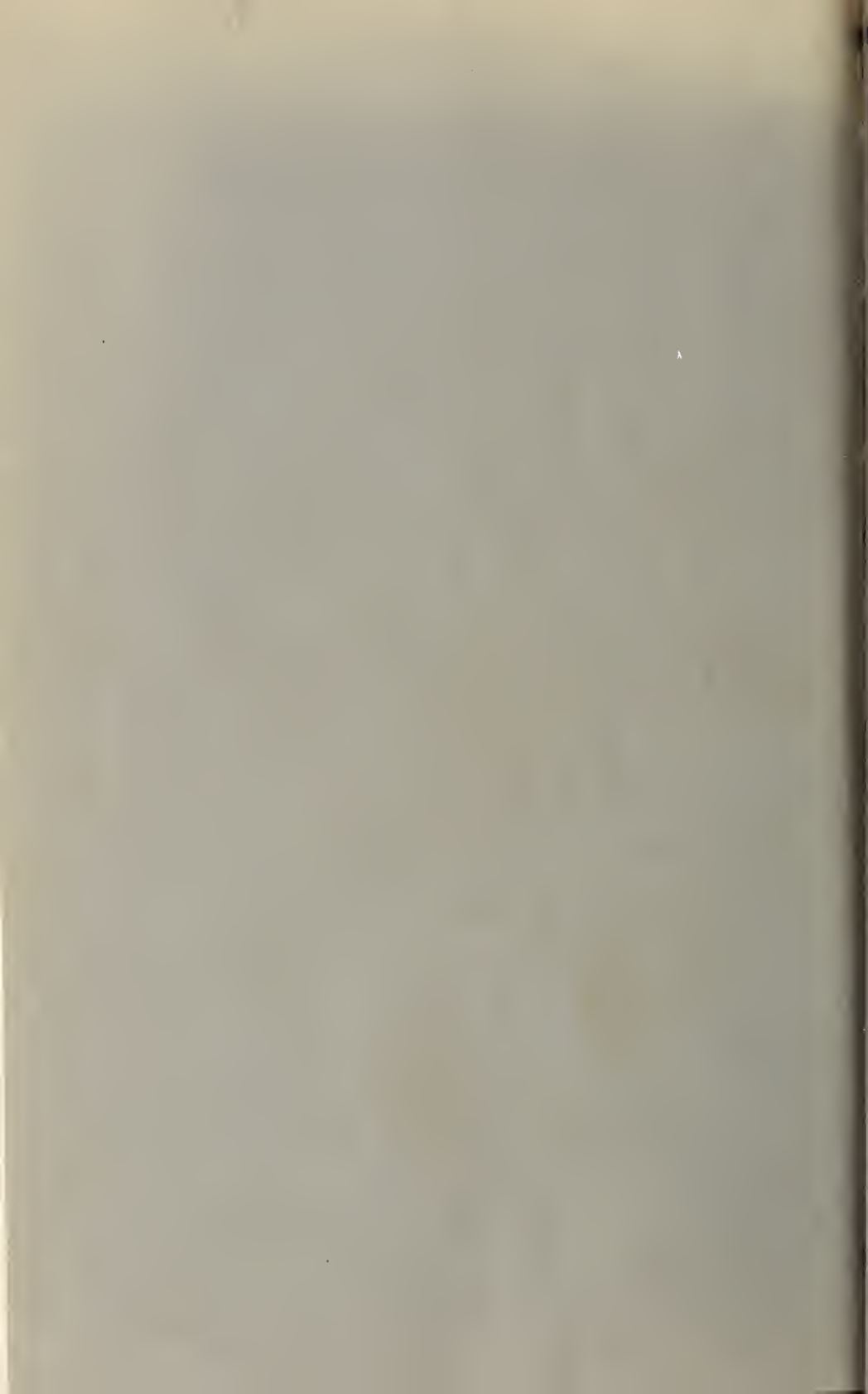
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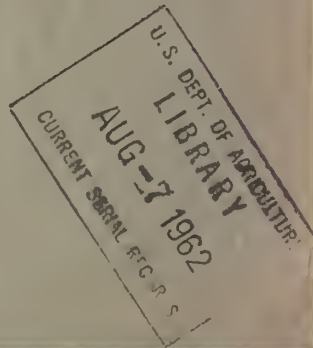
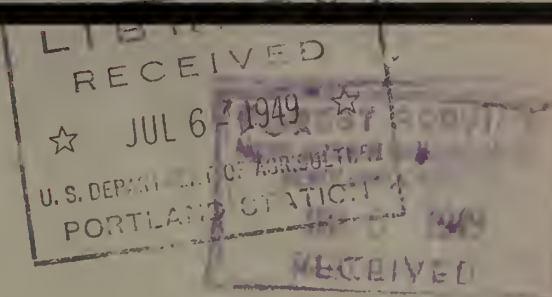
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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL



FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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FM RADIO EQUIPMENT FOR FORESTRY APPLICATIONS

W. F. BIGGERSTAFF

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Present Forest Service frequency modulated radio equipment operates in the 30- to 40-megacycle band. It may be divided into four general types, portable, lookout, mobile, and fixed station. Each of these has a definite use and all are required for a well-balanced network. The number of each type varies, of course, with local requirements. Some of the requirements to be considered are communications on fire lines, communications from fire line to fire camps, communications from fire camps to source of supply, lookout networks where telephone facilities are difficult to maintain, and aircraft activities. It is obvious that no system other than radio will successfully fulfill most of these needs, many of which require equipment of the most portable nature. It was for such reasons that the handy-talkie was given the highest priority on the laboratory development program.

Handy-talkie.—The handy-talkie is the smallest and lightest practical complete radiophone available to date. This general type of set was used extensively by the military forces where extreme portability was a requirement. It is a complete hand-held, self-contained portable radiophone. No accessories or additional equipment is necessary to place it in operation. To simplify operation, the functional controls have been reduced in number to the absolute minimum.

Two specific physical forms are available at the present time. One has the earphone and headphone attached as an integral part of the case and the entire unit is held in the hand for operation; the other employs a standard telephone type handset which is normally carried as part of the handle of the radiophone and detached when used. The antenna in the first unit is telescopic and, when not being used, is carried in clips on the side of the case. The other has a shorter antenna which is bent over and hooked to the opposite end of the case when not in use.

Both have two transmitting channels available, either of which may be selected by the operator. One channel is intended for communication between two similar units, or between a handy-talkie and a mobile set. The other channel is intended for communication with lookouts or with other stations through the medium of the lookout automatic repeater. Both may be used on single-frequency networks, but this arrangement is intended primarily for networks employing automatic repeaters.

Tower set.—The lookout or tower set has been mentioned separately from the other equipment since it has been designed to perform a special function, that of automatic repeating. The lookout or tower set is used primarily to furnish communications for the lookout or towerman and no function has been compromised to secure such service. However, it also provides automatic repeating facilities which are of

extreme value in radio networks employing handy-talkie type equipment.

The tower set consists physically of a basic unit, a control box, and a power supply. The basic unit contains the radio receiver, transmitters, and control relays, and is connected to the control box or control boxes by a multiwire remote-control cable. These controls may be located at distances up to 200 feet from the basic unit.

The use of a separate remote-control box, which has a maximum dimension of under 12 inches, permits installation of the basic equipment at any convenient location within 200 feet of the operating position. For example, where space is at a premium, as in a 7- by 7-foot lookout cab, the basic unit may be mounted in a shelter at the base of the tower and only the control box need to be installed in the tower cab. Where the towerman lives in a ground house, a second control box may also be installed in the living quarters. The radio equipment can then be operated from the tower or from the ground.

The power supply consists of dry batteries contained in wooden boxes located near the basic unit. Two boxes approximately 26 by 10 by 13 inches hold batteries capable of giving about 30 days' service when used continuously.

The Forest Service model (type TF) tower set is completely weather-proof, being housed in a cast magnesium case with all connections brought out through pressureproof fittings. It is intended to be left in place all year. The commercial model is much smaller and since all cables may be easily disconnected, it may be removed to a central shop or warehouse during the "off season." Functional controls are identical on both makes.

Application of two-channel transmitters.—To illustrate the practical use of two transmitting channels and a single receiving channel on all equipment, and also to illustrate the use of the automatic repeating function on the lookout set, we will use the following example:

A typical Forest network may consist of 4 or 5 radio-equipped lookout towers, 2 or 3 mobile sets, 6 to 10 handy-talkies, and a fixed station. The lookout sets will receive on 38 megacycles, which will be called the "Lookout" frequency or "Lookout" channel. The fixed station, mobile sets, and handy-talkies will receive on 36 megacycles which will be called the "Portable" frequency. All types of equipment in this hypothetical network will be equipped, by means of dual channel transmitters, to transmit on the "Portable" frequency or the "Lookout" frequency at the option of the operator. We will assume that one of the lookouts spots a suspicious dust cloud or smoke. He selects the "Lookout" transmitting channel and calls another lookout who may see the same smoke. They discuss the possibility of this being a reportable situation and the probable location of the smoke. As soon as a decision is reached, the individual initiating the action may immediately change to the other channel ("Portable") and make his report to the dispatcher at the fixed station. All of this preliminary conversation between the lookouts would not interfere with traffic being carried on between mobile, fixed station, or portable equipment since all such units would be using the "Portable" frequency while the lookouts used the "Lookout" frequency. This, in effect, makes two separate networks with immediate cross-tie available between all types of equipment.

We will assume, as a result of the report, a truck containing a mobile set was dispatched. As long as the truck was in the immediate vicinity of the dispatching station, the truck operator could talk to the station, but such range is usually short. As soon as the truck is far enough to be out of range of the station it must depend upon the lookout to repeat any instructions from the dispatcher. Verbal repeats are not only slow but in many cases result in confusion. It is at this point that the automatic repeating function of the lookout set becomes of value. By a mere flip of the switch the dispatcher may talk directly to the truck operator via the lookout repeater. To secure such operation it is necessary for the dispatcher to change his transmitter switch to the "Lookout" channel and request automatic repeat. He then calls the truck operator who, after switching to "Lookout" frequency, can carry on a two-way conversation with the dispatcher in the same manner as though he were talking directly to the dispatcher station.

After arriving at the fire, the truck and the handy-talkies may be used together without disturbing the lookouts by using the "Portable" frequency. However, the lookouts will be available, if within range, to any of the handy-talkies or the mobile set as soon as they switch to the "Lookout" frequency. In the same manner, any portable or mobile set may be called, if within range, by the lookout changing to "Portable" frequency.

Since only one receiving frequency is involved in any of these various types of equipment, it is impossible for the operator, through inattention or lack of instructions, to be listening on the wrong frequency.

The reliability of a radio network employing such equipment is accordingly increased in a large measure over any arrangement wherein the operator can select more than one receiving frequency.

Mobile.—Since Forest administration and protection requires a great deal of road travel time, mobile equipment is also important in forestry communication networks.

A wide selection of commercial mobile equipment is available for single-channel networks, but relatively few commercial sources can supply dual-channel transmitters without restricted channel spacing. The value of dual-channel mobile transmitting units is being recognized in the industry and more such equipment is becoming available. The application of such equipment was discussed in the preceding section.

Fixed station.—Fixed stations are those more or less permanently installed at any one location. They may be 110-volt powered, dry-battery powered, or they may be powered by some other source of energy such as storage batteries. 110 volts alternating current is to be desired as a power source because of its usual reliability and low operating cost. If power failures are frequent or voltage fluctuations are exceptionally severe, as may be encountered with a small local power plant, a storage battery system may be used. Where alternating current or storage battery power is not available or is not feasible because of installation costs, dry-battery powered equipment must be employed.

In many cases installations at ranger stations and supervisors' offices are at low elevations. This is a definite handicap where VHF is

used because of the limited operating range over low ground. In such cases consideration should be given to possible remote equipment locations on elevated points with remote control over telephone lines. Installing the equipment on an elevated point, within reasonable distance of the station, may result in an additional improvement, namely, getting the receiver out of local electrical noise and interference. Contrary to popular belief, noise does affect FM equipment, although not to the same extent it affects AM equipment.

Future equipment.—An additional equipment type contemplated for early development or commercial procurement is a pack set. This set will have about the same performance characteristics as the lookout or tower set but will be packaged for back-pack transportation.

The unit will incorporate a loudspeaker, have squelch or silent stand-by, and be generally suited for use by work crews who are to be kept "on call" for fire service.

Other applications for the unit will be to furnish temporary or secondary lookout communications, aircraft communications on a temporary installation basis, fire camp communications, temporary mobile service, and fire line communication for sector operations where one man may be assigned to carry the communication unit for one or more crews.

Dual transmitting channel equipment.—The following material catalogs the new series of FM radio equipment designed by the Forest Service or developed commercially especially for dual transmitter channel operations. Since single-channel mobile and station equipment and a limited selection of single-channel portable radiophones are available from a number of commercial sources, only dual transmitting channel equipment is included in this listing.

HANDY-TALKIE TYPE SF, MODEL B-2

(Forest Service)

The type SF, model B-2 handy-talkie is a frequency modulated two-channel transmitter and single-channel receiver designed for voice communication in the 30- to 40-megacycle band. Weight is 9 pounds; size, 4 by 6 by 14 inches high; length of antenna extended, 7 feet; length of flexible counterpoise, 4 feet.

The receiver is a single conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is 60 decibels at 80 kilocycles. The intermediate frequency pass band is 40 kilocycles wide 3 decibels down.

The transmitter is composed of two complete channels employing phase modulation and capable of 15 kilocycles deviation on voice peaks. Power output is approximately 200 milliwatts. The two transmitters are on a separate chassis from the receiver and may be removed independently for servicing.

The range will depend almost entirely upon location. Two or three miles may be expected between similar units over flat terrain, but distances in excess of 50 miles are possible between elevated points such as mountain peaks.

The power supply consists of three standard flashlight cells and two miniature 45-volt "B" batteries. The two "B" batteries are connected

in parallel for the receiver and in series for the transmitter. The change in connections is made by the push-to-talk switch.

Receiver current drain is 400 milliamperes at $1\frac{1}{2}$ volts and 10 milliamperes at 45 volts. Transmit current drain is 400 milliamperes at $1\frac{1}{2}$ volts and 18 milliamperes at 90 volts.

Units produced after January 1949 are equipped with the necessary attachment fittings to permit the use of a separate antenna and special head set and close talking microphone for aircraft application.



Left, handie-talkie type SF, model B-2. Right, handie-talkie type FH2TR-1AL.

HANDY-TALKIE TYPE FH2TR-1AL

(Motorola)

The FH2TR-1AL handie-talkie is a two-channel transmitter and single-channel receiver of commercial design used for voice communication in the 29- to 39-megacycle band. Weight is $11\frac{1}{2}$ pounds; size, 10 inches high by $12\frac{5}{8}$ inches long by $3\frac{1}{8}$ inches wide.

The receiver is a superheterodyne of cellular construction, each cell being a complete operating stage. Sensitivity is 0.5 microvolt for 20-decibel quieting. Selectivity is such that the attenuation is 40 decibels at 40 kilocycles and 80 decibels at 80 kilocycles. The audio output is 4 milliwatts into a 250-ohm load. Crystal control of the local oscillator is incorporated and the stability is within plus or minus 0.022 percent over a temperature range of -20° to $+60^{\circ}$ C.

The transmitter is composed of two complete channels which are also of cellular construction. Phase modulation is employed and the output deviation is plus and minus 15 kilocycles. The RF power output is 500 milliwatts. Frequency stability is plus or minus 2 kilocycles over the temperature range of -20° to $+60^{\circ}$ C.

The operating range between units, using the normal portable antenna, is 1 to $1\frac{1}{2}$ miles over flat terrain. This range increases with elevation of the stations to distances in excess of 50 miles between mountain peaks. All ranges vary depending on local conditions of terrain, surrounding objects, and local noise conditions.

The power supply is composed of 4 standard flashlight cells and 3 miniature $67\frac{1}{2}$ -volt "B" batteries. Provision is made for 6 cells if longer life is desired. Battery life is 6 to 10 hours depending on transmitter usage.

Accessories are available for aircraft use and a special antenna is available for semiportable use.

The same unit may be secured with a single-channel transmitter only.

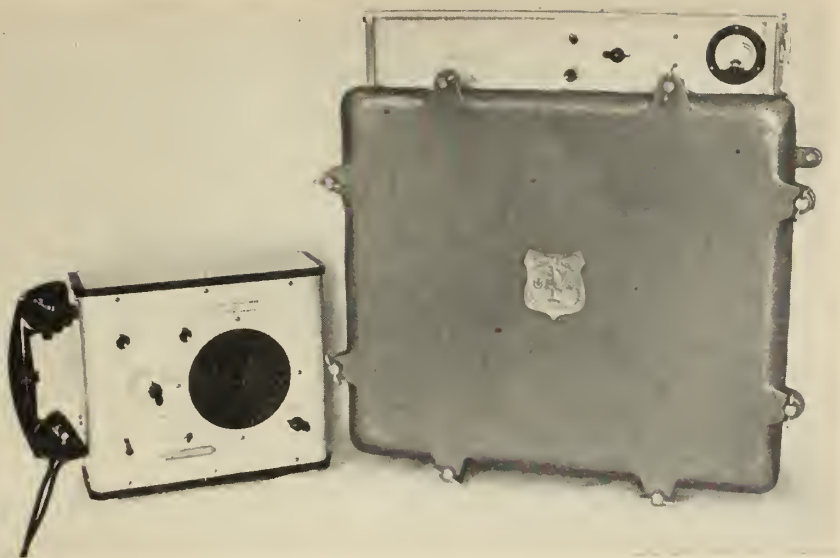
TOWER SET TYPE TF, MODEL A-T2-R **(Forest Service)**

The type TF, model A-T2-R, is a frequency modulated two-channel transmitter and single receiver designed for voice communication and automatic repeating in the 30- to 40-megacycle band. It is dry-battery powered and intended primarily for use as a lookout or tower set. The transmitters and receiver are mounted in a weatherproof cast magnesium case and all leads to the control box, batteries, and antennas are brought out through pressureproof fittings. The equipment is operated from a control unit containing the loud-speaker, handset and hang-up box, volume control, and various switches. The control box may be located up to 200 feet from the basic unit.

Weight of basic unit is 51 pounds; weight of control unit, 9 pounds; size of basic unit, 24 inches wide by $23\frac{1}{2}$ inches high by 10 inches deep; size of control box, 16 inches wide by 11 inches by $4\frac{1}{2}$ inches deep; size of battery boxes (2), 26 by 10 by 13 inches high.

The receiver is a single conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is better than 1 microvolt for 20-decibel quieting. The intermediate frequency amplifier band width is 40 kilocycles 3 decibels down. All connections are made to a terminal strip and the receiver may be removed from the case for testing or replacement without disturbing the other equipment.

The transmitter is a conventional frequency modulation transmitter employing balanced phase modulators and capable of 15 kilocycles



Tower set type TF, model A-T2-R.

deviation on voice peaks. Radio frequency power output is approximately 2 watts. The usual arrangement consists of two transmitters (in addition to the receiver and relay controls).

Automatic repeating or local control is secured by operation of a single switch on the control unit.

No definite range can be stated since this is a function of antenna height, location, and other local factors. Distances of 5 or 10 miles may be expected over flat ground with antennas at a height of 10 to 15 feet. Distances of a hundreds miles or more are possible from elevated points or mountain peaks.

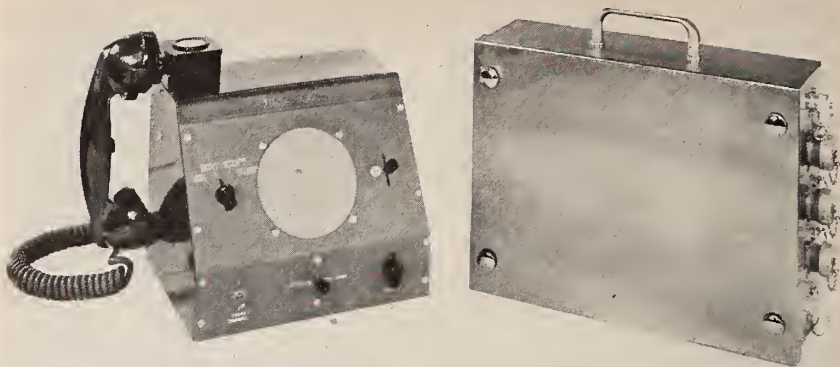
Receiver current drain is 500 milliamperes at $11\frac{1}{2}$ volts and 16 milliamperes at 50 volts with an additional 16 milliamperes at 135 volts when the auto system is used or when the squelch is "open."

The transmitter current drain is 500 milliamperes at $11\frac{1}{2}$ volts and 50 milliamperes at 135 volts.

TOWER SET TYPE FHRT2TR1A1

(Motorola)

The type FHRT2TR1A1 tower set is a complete dry-battery operated radiophone and automatic repeater. The basic unit is housed in a stainless steel case approximately $10\frac{1}{2}$ by 14 by 4 inches and will weigh 15 to 20 pounds less batteries. This set with specially designed boxes for packing two antennas, and the necessary batteries to provide 50 to 100 hours continuous service, will serve as a portable repeater for use on a large fire where repeater service is required and cannot be secured from existing fixed stations. It is of commercial manufacture produced from specifications developed by the Forest Service Radio Laboratory. The set consists of two basic units, a trans-



Tower set type FHRT2TR1A1.

mitter and receiver housed in a small metal case with the associated relays, and a control box containing the handset, speaker, and operating controls. An additional control unit may be connected to provide a second operating position. Power is supplied by dry batteries.

The receiver is a single conversion superheterodyne of cellular construction. Sensitivity is 0.5 microvolt for 20-decibel noise quieting. A squelch circuit is employed that controls the audio output and operates the transmitter control circuit for repeater operation. Selectivity is 40 kilocycles 40 decibels down and 80 kilocycles 80 decibels down. The receiver incorporates a stable crystal-controlled oscillator to furnish the injection voltage.

The transmitter consists of two complete channels employing phase modulation capable of 15 kilocycles deviation. Radio frequency power output is $1\frac{1}{2}$ watts. Stability is within plus or minus 0.002 percent from -20° to $+60^{\circ}$ C.

MOBILE TYPE KF, MODEL A-T2-R (Forest Service)

The Forest Service type KF, model A-T2-R is a complete mobile FM radiophone designed for operation in the 30- to 40-megacycle band and incorporates a two-channel transmitter and single-channel fixed-frequency receiver. The two-transmitter channels and the receiver with associated power supplies are mounted on one chassis and under one dustproof cover. Such construction makes a very compact unit. Since the receiver is fixed in frequency by a quartz crystal-controlled oscillator, no tuning is necessary by the operator and one major source of failure is avoided. The only controls necessary for operation of the unit are housed in a small box 3 by $4\frac{1}{2}$ by 2 inches that may be conveniently located in the driver's compartment. The controls consist of an ON—OFF switch, speaker volume control, squelch adjustment, and transmitting channel selector switch.

The receiver is a double conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is better than 0.5 microvolt for 20-decibel quieting. Positive noise compensated squelch is incorporated, the threshold of which is



Mobile type KF, model A-T2-R.

adjustable at the operating position. The intermediate frequency amplifier bandwidth is 30 kilocycles 3 decibels down.

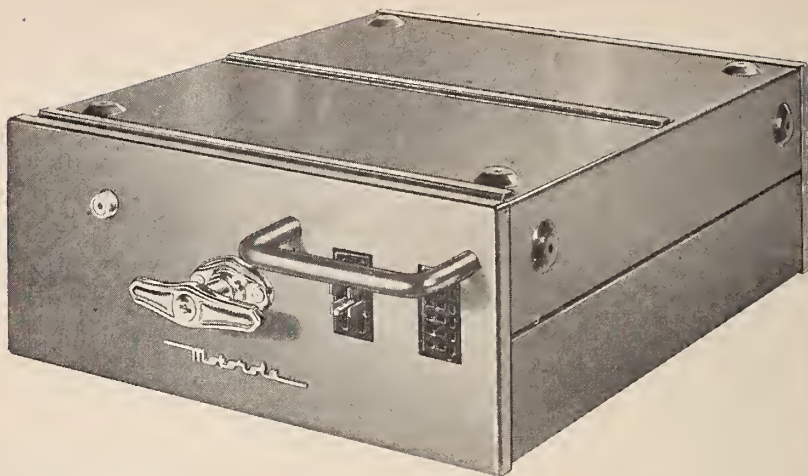
The transmitter is two channel, capable of 25 watts output on any two frequencies in the 30- to 40-megacycle band. Either frequency may be selected from the control box. A crystal-controlled radio frequency voltage is phase modulated and multiplied a total of 32 times to provide output with deviation capabilities of plus or minus 15 kilocycles.

Accessories include speaker, control box, microphone, and cables. Weight is 60 pounds; size, 16½ inches wide by 8½ inches high by 15 inches deep; stand-by current drain, 12 amperes; transmit current drain, 22 amperes.

The range will vary considerably, depending upon the location of the two stations and the terrain over which communication is carried. It will vary from a few miles for two similar units communicating over flat ground to 50 miles or better from elevated points.

MOBILE TYPE FM2TR8OD(B)1SP1 **(Motorola)**

The type FM2TR8OD(B)1SP1 is a mobile radiophone of commercial design manufactured to operate in the 30- to 40-megacycle band. It incorporates a two-channel transmitter and a single-channel receiver designed for voice frequencies. Size is 6½ inches high by 21 inches wide by 20¼ inches long; stand-by current drain, 10 amperes; transmit current drain, 47 amperes.



Mobile type FM2TR8OD(B)1SP1.

The receiver is a superheterodyne having a sensitivity of 0.4 micro-volt or less than 20-decibel quieting. Receiver-injection voltage is provided by a stable crystal-controlled local oscillator. Alternate channel selectivity is 85 decibels or better at 80 kilocycles.

The transmitter is composed of two separate channels capable of operating on any predetermined frequency in the 30- to 40-megacycle band. Phase modulation is employed and the deviation capability is 15 kilocycles. Instantaneous deviation control is incorporated in the modulator section. The radio frequency power output is 30 watts.

MOBILE TYPE 2164

(Link)

Transmitter mobile type 2164 is 8 inches by 10 inches by 12 $\frac{1}{2}$ inches. Weight is 30 pounds; power output, 25 watts either channel. Receiver separate, same size as transmitter. Total stand-by current drain is 5 $\frac{3}{4}$ amperes; transmitter current drain, 23 amperes.

REGION 1 STRETCHER CARRIER PROVED IN AIR RESCUE OPERATION

H. K. HARRIS

Forester, Region 1, U. S. Forest Service

The latest model of the modified Stokes litter with wheel attachment, known as the stretcher carrier, developed for use of the Region 1 air rescue squad and described and illustrated in Fire Control Notes,¹ received its first real test last fall. It was used in the evacuation of a hunter who had been lost in the remote Selway River area of Idaho. When found, the hunter was so weakened by exposure and starvation that it was necessary to move him to a hospital as quickly as possible.

William C. Wood, parachute project foreman in charge of the air rescue squad reports the action. Excerpts from his interesting report follow:

On October 11, 1948, at 11:30 p. m., I was notified of a call to assist in the search of a lost hunter in the vicinity of Pettibone Creek on the Selway River. Because of the late hour and short notice, I was able to contact only eight men willing to go on the mission. Upon arriving at the parachute loft the next morning, I was informed that four additional men were available. Also available was Parachute Foreman Albert W. Cramer, who was to assist me in organization.

Flying in a C-47, we arrived over the jump spot at 10:30 a. m. and were on the ground with full equipment at 11:30 a. m. After a light lunch, the 10 men were lined out 20 to 30 feet apart between Cramer and myself. We contoured across the search area with Cramer blazing a line to the boundary of our area. We returned in the same manner except that Cramer followed his blaze back and I put in a new blaze line at the lower edge of the strip. This procedure was closely followed in our 2½ days of search.

Fortunately the lost hunter, a man 65 years old, was found Thursday night, October 14, 1948, by Ranger Jack Parsell and Alternate Side Poppe. He had been without food for 7 days.

Parsell was searching the creek bottom for tracks and Poppe was paralleling the creek at distances from 50 to 100 feet, when Parsell noticed a jumper streamer hanging in a bush. Three of our jumpers had left the orange signal streamer to facilitate finding their jump spot when they returned to retrieve their chutes. Parsell yelled "Hey, Sid, here's a jumper signal!" Immediately following Parsell's exclamation, Poppe heard a weak cry, "Hey!" Upon investigating, he discovered the lost hunter leaning against a tree about 20 feet from the edge of the creek, directly opposite the jumper streamer.

They covered the patient with their jackets and, while Parsell went for help, Poppe kindled a fire. Parsell reached camp at 5:30 p. m., just as our crew came in for supper. We immediately gathered a kapok bag, a cargo manta, and about 30 feet of cargo chute line for improvising a stretcher. A canteen of hot coffee and another of hot sugar water, an ax, and all available flashlights were also taken.

We reached the patient at 6:30 p. m. Exposure and starvation had weakened him considerably and because of violent trembling it was necessary to assist him in taking hot stimulants. While constructing the stretcher and administering first aid, I asked the patient if he had seen the orange jumper signal, and he

¹ H. K. Harris. Stretcher carrier. U. S. Forest Serv. Fire Control Notes 10 (1): 10-11, illus. 1949.

replied "Oh, is that what that was? I knew it didn't belong there, but I couldn't get over there to find out, so I just stayed here." Undoubtedly, the orange streamer played an important role in saving the man's life.

With the lost man on the pole and canvas litter, we reached the search camp at 8 p. m. A good thick mattress of pine boughs with a kapok bed made him quite comfortable. Canteens, improvised as hot-water bottles, were added to keep him warm. The patient's physician was contacted by radio at 9:30 p. m. and we were instructed to evacuate the patient as soon as possible. The modified Stoke's litter and wheel attachment were ordered for delivery by plane. The following morning, October 15, at 8:30 a. m., the stretcher and wheel were dropped.

By 9:30 a. m. camp was broken and the stretcher crew started out. One man guided the crew through logged-up sections of trail. It was soon learned that detouring for windfalls less than 4 feet high resulted in slowing the rate of progress. The best method was to have the guide limb the windfalls to the width of the trail, and the crew, upon encountering them, would lift the wheel stretcher over. Windfalls having a vertical clearance of at least 4 feet were limbed on the underneath side and the litter was wheeled under them. It was important to have the guide working well in advance of the crew to prevent the litter from being held up while clearing was accomplished.

Pettibone Creek was forded twice by merely adding extra men to the sides of the stretcher and sloshing through the shallowest portion of the ford.

On a good trail, level, or downhill grades, it was possible for two men to pull the stretcher at a fast dog-trot. Uphill grades were more tiring, but a good rate of speed was maintained by adding side men to assist the main bearers.

At least six stops were made on the trail to administer water and hot stimulants to the patient. Twenty minutes were spent feeding the patient at the Selway River.

We arrived at Shearer landing field, at 2 p. m. (It was estimated that it would require approximately 8 hours to evacuate the patient.) We had moved the patient from the Deep Saddle Trail on Pettibone Creek to Shearer landing field, a distance of 14 miles, 6 of which were badly logged-up, steep, and not maintained, in 4½ hours. With a conservative estimate of 1 hour spent in attending the patient, I believe we are justified in claiming the fastest evacuation of a litter patient ever effected in the mountainous terrain of Region 1.

We may have been in error in reporting that the Stokes litter was developed by the Army. It is used by both Army and Navy. Modifications for use on narrow, rocky trails, and transporting persons down steep slopes, over windfalls and through brush and timber was necessary to make it most effective for our work. This was a Forest Service development. Collapsible handles facilitate airplane transportation, and light tubing along each side strengthen the stretcher. The carrier wheel is detachable and may or may not be used, depending upon ground conditions. The unit is accordingly packed for dropping in two separate packages. There is little question but that speed and ease of operation is increased by the use of the wheel in open areas or along trails. (Detailed descriptions of all equipment, organization, and training of the Region 1 air rescue squad is being prepared as a chapter of the new Air Operations Handbook.)

DUAL PURPOSE FIRE EQUIPMENT BOXES

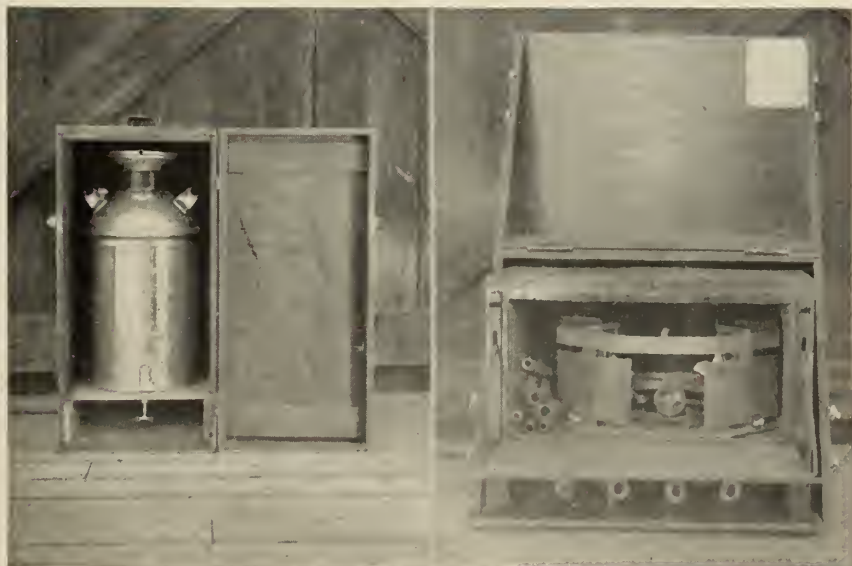
ALVIN EDWARDS

Storekeeper, Mendocino National Forest

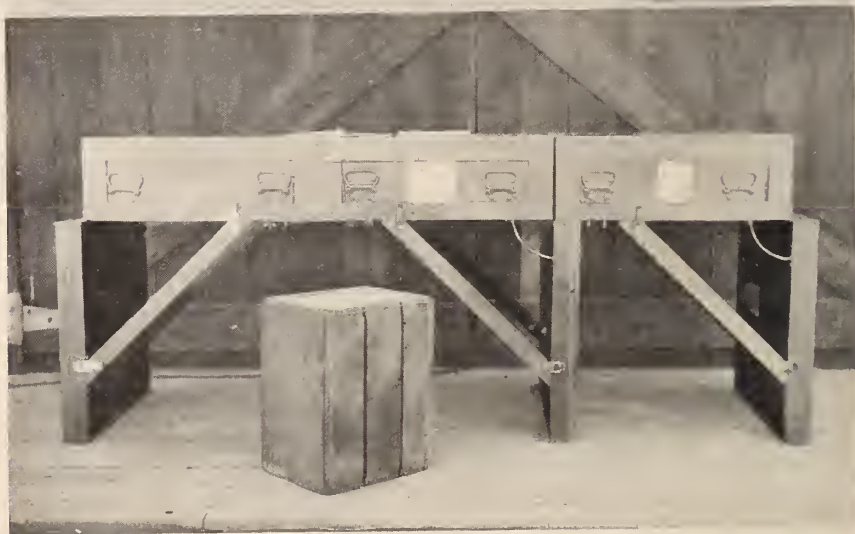
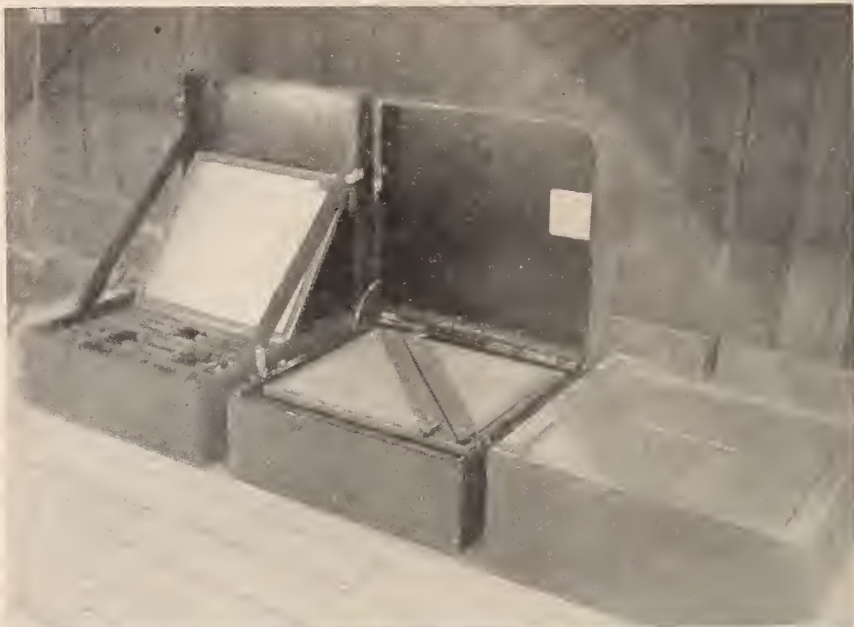
Some of the specialized fire camp equipment was difficult to transport without the possibility of damage or the scattering of some of the pieces. To prevent damage and to assemble complete outfits in containers special boxes were prepared. These boxes were also designed to serve a useful purpose in the fire camp. They were used during 1948 and found satisfactory for the purposes intended.

Hot or cold drink dispenser.—A self-closing spigot, sometimes called a restaurant water dispenser, was fitted to the bottom of a 10-gallon milk can and a box constructed to prevent breakage in transit. The dispenser sits securely on top of the box in the fire camp. The men can serve themselves by merely pushing their cups against the self-closing spigot.

Fire camp stove oven.—The box built for the fire camp stove oven also contains the hot-water stove, oven legs, and regulator. It was designed to serve as a radio desk in the fire camp. For that reason 1-inch pipe flanges were mounted to the bottom of the box on each corner so that 1-inch pipe legs could be quickly attached. The lid of the box can serve as a sunshade for the radio operator by being tilted forward and held in position by cord or chain between the two handles on one side near the top of the box.



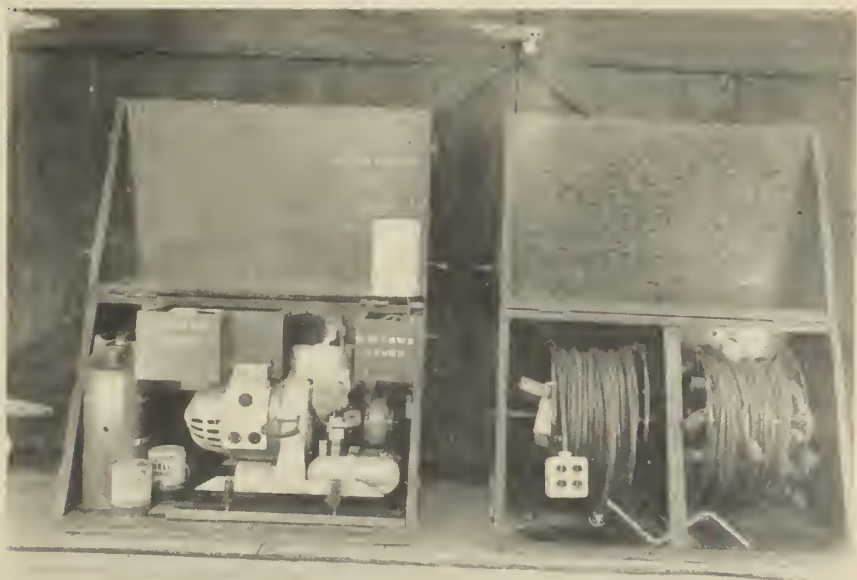
Left, drink dispenser with self-closing spigot. Right, fire camp stove oven with oven door open to show hot-water stove and box legs.



Upper, fire camp stove boxes with braces in place, braces detached, and top down. *Lower*, the three boxes set up as a table.

Fire camp stoves.—Boxes were built for fire camp stoves and contain the stove burners, stove grill, a solid grill plate with grease troughs, and stove legs. By the use of special braces and short supports fastened with wing nuts two of the boxes can be converted into a table that may be used for any purpose needed in the fire camp. The third box increases the length of the table.

Portable generator and accessories.—Two boxes were designed to contain the portable generator and lighting cable. The one with the generator also carries fuel, grease, light bulbs, and servicing tools. The two cable reels in the other can be operated individually with the hand crank.



Left, generator with fuel, oil, bulbs, and tools. Right, lighting cable.

Fire Suppression at a "Profit" in Delaware.—For 1948, a number of States are able to boast of a good fire record because of the lowest number of fires, smallest average-size fire, lowest number or lowest percent of protected acres burned for any year since the beginning of organized fire protection. To this, State Forester Bill Taber of Delaware has added one more record which is doing a fire fighting job at an apparent profit.

This unusual situation was brought to light when State Forester Taber submitted his 1948 annual fire report. The report had not been completed because fire suppression costs showed a minus quantity. In other words, collection of suppression costs from individuals responsible for fires had exceeded actual 1948 suppression costs. This, of course, included fires occurring prior to 1948, but whose suppression collections were made in 1948. Bill apparently wasn't sure how to show the distribution of a minus quantity on the form and frankly, since it was something out of the usual, some thinking was done in the regional office before final action was taken.

Delaware has enjoyed a good fire record for a number of years. In these same years, Delaware's law enforcement record has shown a percent of convictions running from 76 to 100. Making it unprofitable to start a fire is one of the reasons behind Delaware's showing a "profit" in fire suppression.—EPHE M. OLLIVER, *Region 7, U. S. Forest Service.*

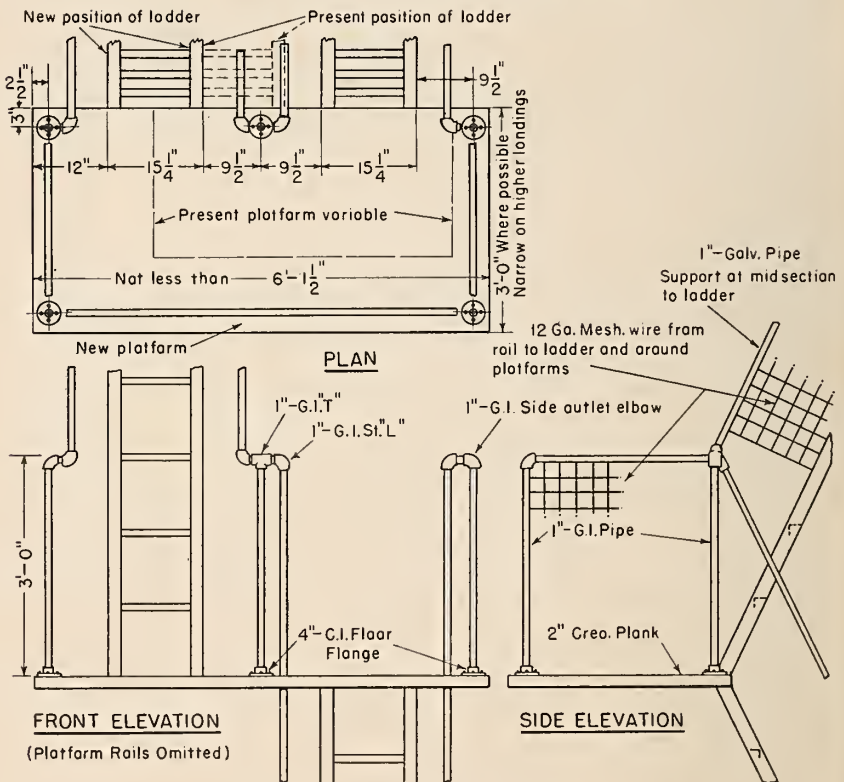
SAFETY LADDER FOR AN INSIDE LADDER TYPE TOWER

R. I. LOWNDES, JR.

Forest Engineer, Cherokee National Forest

The usual inside ladder type tower is probably one of the most difficult to climb, especially if tools, equipment, or other objects burden the climber. Certainly it is most dangerous, because of the very narrow, steep ladders and the narrow short platforms.

Towers of this type do not, ordinarily, possess sufficient strength in their structural design to carry the added weight and resistance to wind that replacement of the ladder by a stair would inflict on it. Also, the narrowness of the ladders, plus their closeness entering and leaving each platform, does not allow sufficient space to add handrails or similar supporting structure to be used as a frame for wire mesh.



Designed by: R.I.LOWNDES JR.

The platforms can be enlarged without changing the supporting members by overhanging the platform boards. A few additional anchor bolt holes will have to be drilled through the supporting members. The ladders can be separated one additional ladder width by using the present outside ladder stringer anchor bolt holes for inside ladder stringer anchor bolt holes at the bottom and top of alternate ladders.

One-inch galvanized iron pipe is amply strong for all railings and posts, and these will not endanger the stability of the tower by their added weight or wind resistance. This device (see drawing for details) is easily fabricated and installed by anyone with a knowledge of pipe fitting.

"Watermelon" Hose Roll.—Gathering up wet linen hose after use on a fire is one of the problems in forest fire fighting. Much of the new linen hose and particularly the treated forestry hose becomes unwieldy and difficult to manage. A small quantity may quickly fill a stake body truck before the job is barely begun.

At the Northeastern States forest fire equipment meeting in New Jersey in 1947, the Connecticut foresters put on a demonstration of rolling up wet hose.



A roll of hose takes shape.

The demonstration created sufficient interest to have it repeated again at the Fryeburg, Maine, equipment meeting in 1948. For those interested but unable to attend either meeting and because of the very limited distribution of the 1947 and 1948 reports, the following steps have been taken from the reports:

1. Wet hose is gathered up a length at a time by using a stick, piece of board, or straight pole 2 or 3 feet in length as a core.
2. After one complete wind of hose has been made, the core is turned at a 90° angle before making the next lap.
3. Turning and winding are repeated until the entire length is rolled.
4. The loose end is given a half hitch and the coupling is tucked under to prevent unwinding. After some practice, no rigid core or stick is necessary in making a neat pack job.

—EDWARD RITTER, *Forester, Region 7, U. S. Forest Service.*

SAFE CARGO DROPPING

LAWRENCE J. SOHLER

Airplane Pilot, Region 6, U. S. Forest Service

The following is an attempt to bring out some of the important points in connection with cargo dropping, such as air speed, air resistance, force of gravity, airplane angle-of-attack.

When an airplane is flying at a reduced speed, the anchor fittings for the tail brace wires or struts may be about the same level as the cabin floor at the door. Since many types of airplanes are used for cargo dropping, some will even have these fittings below the floor level at reduced speed. These present the more critical arrangement. Airplanes, which have a high cruising speed or a comparatively low location of the horizontal tail surfaces, associated fittings, and brace wires or struts, may inherently present extra hazards for cargo dropping.

Force of gravity.—Any object regardless of size, shape, or weight will fall the same amount in a given length of time except as retarded by air resistance. For our purpose, air resistance which will reduce the rate of fall will not have to be considered because we are not concerned with the rate of fall for longer than $1\frac{1}{2}$ seconds after the packages are released. One second after packages are released they will be falling at 32 feet per second or about 22 miles per hour. This speed is not enough to cause air resistance that will vary the rate of fall appreciably on any airplane cargo to be considered here.

At a rate of 90 miles per hour or 132 feet per second, an airplane will travel $8\frac{1}{4}$ feet in one-sixteenth of a second. That is the time it will take for the tail of some airplanes to get to the same place in space where the door was. An object will fall only $\frac{3}{4}$ inch in that length of time. Why, then, do not many packages strike the tail brace wires?

There are two reasons. One is because the packages are some distance from the side of the fuselage when the tail passes over them. Because of the angle at which the tail brace wires attach to the fuselage, the farther away from the fuselage the packages are when the tail passes over them, the better the clearance will be. The other and principal reason is the packages travel forward some in the direction the airplane is traveling, because of their momentum before the air resistance slows them down. The rate at which this forward travel is reduced depends upon the weight, shape, and size of the package. A light bulky package will travel forward only a short distance, and, therefore, will be passed by the airplane tail before it has much time to drop.

When cargo is only just pushed out of the door of an airplane, the elapsed time until the tail passes over it is the only figure needed to determine how far the package will be below the tail surfaces and

brace wires. One package can be considered to fall just as fast as another during the first second for our purpose. We assume no packages will be discharged which are so shaped that they will present a lifting surface and create any appreciable amount of lift due to the relative air speed.

We know that at 90 miles per hour it will require one-sixteenth of a second for the tail to pass the point in space where the door was when the cargo was pushed out. If a very light package is discharged, it will not travel forward far because of air resistance. A heavy package will overcome the air resistance and travel forward some. Because of this forward travel, the elapsed time will be greater before the tail passes over the package, and it is only this additional length of time that will cause it to be farther below the tail surfaces. If this amounts to one-half second, the tail will pass 4 feet over it: in 1 second it will be 16 feet above it, etc.

Attitude or position of airplanes in dropping.—Air speed should be decreased during the dropping operation to reduce the parachute opening shock and minimize the probability of tearing the parachute from the cargo package. Air resistance increases at the square of the air speed, and at 100 miles per hour it is twice as much as at 70 miles per hour. Since the air resistance is less at reduced speed, packages will travel forward farther relatively after being pushed out, and the elapsed time until the tail passes over them will be greater. However, by reducing the air speed the tail is lowered to increase the angle-of-attack to maintain level flight. Reducing the air speed on a fast airplane to 80 miles per hour will not make it as desirable for cargo dropping as one that normally flies at that speed. The tail will be kept lower and the packages will have farther to drop to clear it.

Difference in airplanes.—An appreciable difference between makes of airplanes will be found in the level of the cabin floor at the door and the horizontal stabilizers and their bracing wires or struts. Because a package or parachute may clear safely on one airplane does not hold that it will on another make. Airplanes having a high wing loading will of necessity have to be flown at a greater angle to maintain level flight at a given air speed.

Safety measures.—When packages are discharged they must be put out as low as possible and should be given a start in a downward direction. Packages must be prepared for dropping so that they will offer as little resistance as possible to insure at least a certain amount of forward travel after being discharged.

The above information indicates the necessity of being careful that no parachute ever gets out ahead of the cargo. Very light packages are dangerous and should not be dropped except when proper methods are employed. Packages that offer a wide flat surface may cause serious trouble if they are not properly discharged because the reaction of the air may cause them to rise rather than fall immediately after being discharged. One safety measure has been to modify the Region 5 Noorduyn and the three Region 6 Noorduyns to permit discharging the cargo through an opening in the floor in the rear section of the cabin. The intended purpose of this hatch is to obtain maximum clearance of the tail surfaces and brace wires with all cargo and parachutes being discharged. The seriousness of the cargo dropper's work should be given ample consideration by everyone connected with cargo dropping.

MISSOURI CONSTRUCTS WOOD TOWERS

GEORGE O. WHITE

State Forester, Missouri Conservation Commission

In the early days of fire control work before the modern steel structures came into being, a considerable amount of ingenuity must have been demonstrated by Federal and State Foresters in constructing lookout towers. We learned this because the program of the Division of Forestry of the Missouri Conservation Commission, which started in 1938, was just nicely underway when steel was given a high priority for defense purposes and became practically unobtainable.



Constructing foundation for 60-foot wooden tower.

In addition to our inability to secure steel towers, our program operated on a very small budget and so we would hardly have been able to purchase modern towers even if they had been available. It is probable that most of the early wooden towers were made without detailed plans; at least none could be found to serve as guides for a struggling young forestry program.

Our district foresters used imagination in setting up temporary structures, most of which were very crude but served, temporarily at least, to find more fires than we could control. Now, by a process of evolution, we have developed a wooden tower which is quite satisfactory to our needs. It has enabled us to build up a good system of lookout towers, which we could not have done had we been forced to wait for steel and the funds to procure it.

At most of the State tower sites in Missouri, a 60-foot tower gives quite satisfactory coverage and the standard we have developed covers this height. Four poles of creosoted southern yellow pine, 60 feet in length, provide the legs; the stairway and braces are of untreated

rough oak; and the cab is of finished lumber. The tower is designed to use braces and timbers, other than the legs, of not more than 16 feet in length so that native Missouri timber can be used. It is difficult to find portable mills cutting longer lengths here. We feel that the construction of this type of tower has resulted in a considerable saving and has made possible facilities that could not have otherwise been provided.

We have kept a careful record of expenditures on a number of these towers and although there is some variation in their costs, an average is about as follows:

Material	-----	\$1,000
Specially employed labor	-----	850
Regular Commission employees (contributed time)	-----	290
Use of Commission equipment	-----	60
Total cost	-----	2,200

Those of you who have constructed steel towers recently will be able to compare the cost with these wooden towers. It is understood that the steel alone in a 68-foot tower might cost close to \$3,000 at present prices, not counting the cost of the foundation, plus labor of construction.

Of 51 towers operated by the Missouri Conservation Commission, 30 are wooden towers of approximately the same design as shown in the photographs.



Left, erecting fourth pole. Note the A-frame used to raise pole. Poles are prepared for braces prior to elevating them into position. Right, completed tower with exception of radio antenna and flagpole.

VEHICLE BRAKE TESTER

ARCADIA EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

The instrument described in this article has proved to be very useful in determining the adequacy of brakes on various loaded fire vehicles, and in training and testing vehicle drivers.—*Ed.*

The standard AAA brake tester has been a necessary piece of equipment for use in the Region 5 driver-training program, as well as for vehicle testing by the Arcadia Equipment Development Center. The double-barreled electrical detonating brake tester, which is a patented article, was obtained from the AAA at a cost of approximately \$17. This unit allows driver reaction and vehicle braking distances to be measured separately.

The electrical detonating brake tester consists of the four units, brake-pedal switch, stopping-signal switch, interconnecting wiring, and detonator unit (fig. 1).

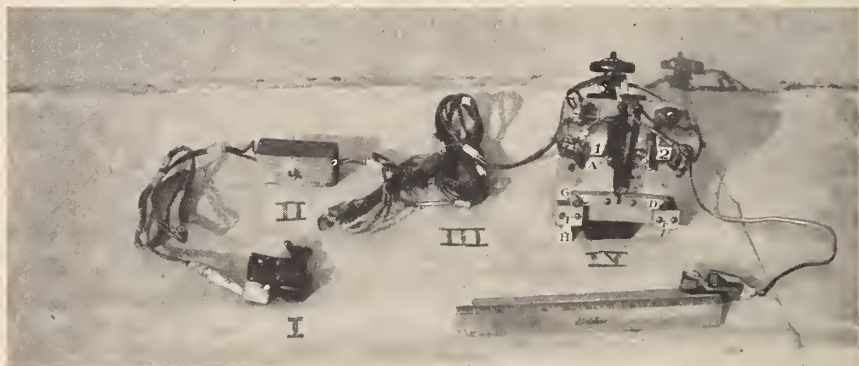


FIGURE 1.—AAA electrical detonator brake tester as modified by U. S. Forest Service: I, brake-pedal switch; II, stopping-signal switch; III, interconnecting wiring; IV, detonator unit.

As originally received, the AAA brake-testing unit had a strap attached at the top so that it could be hung over the running board by laying the strap on the floor of the car and then closing the door. For late-model passenger cars this method was satisfactory, but for the varying types of trucks, passenger cars, and other equipment to be checked, a different mount was needed. A clamp was designed for mounting the detonator on any type of bumper, running board, or other convenient part of the vehicle (fig. 2).

The detonator unit itself (fig. 3) consists of two magnetic switches (solenoids), two triggers, two hammers, and two blocks or barrels, each of which holds a blank cartridge and a piece of chalk.

Figure 3 shows the right hammer D having been fired, while left hammer C is ready to fire. Electric magnet 1 holds trigger A in a vertical position, which in turn holds spring-actuated hammer C in a cocked position. When the circuit is broken, hammer C strikes blank cartridge G, which expels chalk H onto the road surface, making a white mark.

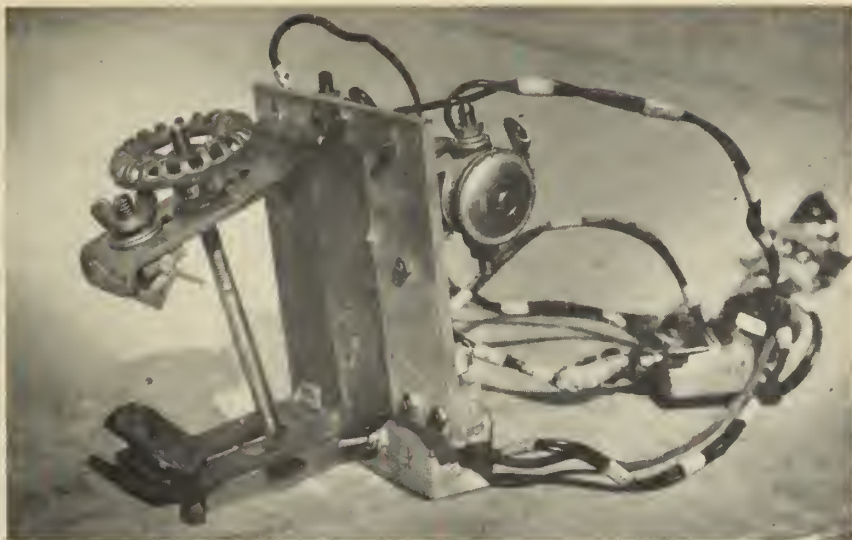


FIGURE 2.—Universal clamp mounting for brake tester.

As originally supplied, a mercury switch mounted in a small block of wood was attached to the brake pedal by means of a flat steel plate that went over the top of the brake pedal and two spring prongs that slipped under the pedal face. Since this system of mounting did not

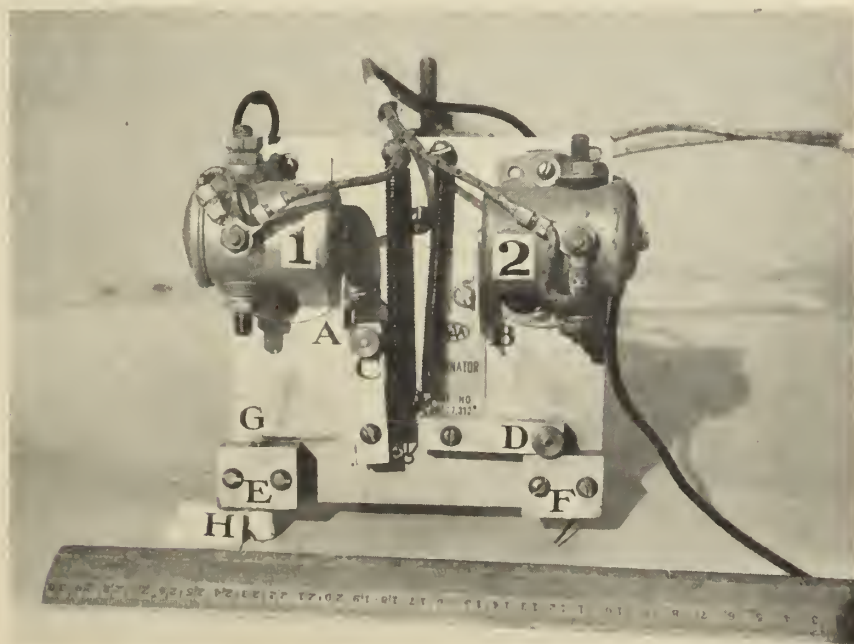


FIGURE 3.—Detonator unit of AAA brake tester: 1 and 2, Magnetic switches; A and B, triggers; C and D, hammers; E and F, blocks or barrels, each of which holds a blank cartridge (G) and a piece of chalk (H).

fit all the types of equipment that were to be tested, the switch was mounted on a small "C" clamp. This allowed for a more secure mounting of the switch on the shank of the brake pedal of all vehicle makes and models. In operation, the function of this mercury switch is to break the electrical circuit to the second magnetic switch, and thus place a mark on the pavement at the instant the brake is applied by the operator.

Originally, the stopping-signal switch controlled only the current to the first solenoid. Under this condition, once the detonator was set, it was imperative that the brake pedal *not* be touched by the operator until the test was under way. Otherwise, the misfire of No. 2 marker would void the particular test. To obviate this difficulty, the wiring was revised as shown in figure 4.

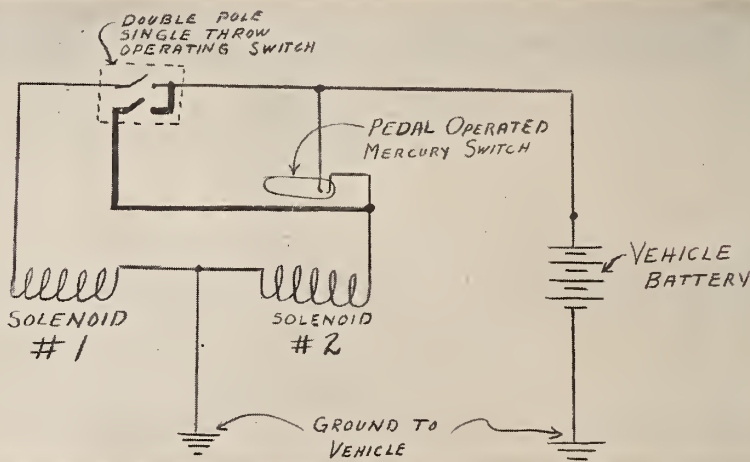


FIGURE 4.—Revised wiring diagram of AAA brake tester. Extra heavy lines denote the added wiring and switch pole that acts as a shunt around the pedal-operated switch until the stopping-signal switch fires number 1 solenoid and energizes the pedal mercury switch.

Wiring of the unit was increased in length for more convenient mounting of the equipment (fig. 5). The ground side of the solenoid connects through the ground wire and spring clip to any convenient grounded point on the frame of the vehicle. The hot wire is of sufficient length so that its spring clip can be connected either to the battery direct or to a "hot" terminal under the instrument board.

In operation, the unit works as follows: After the detonator is mounted, loaded, and set, the driver is instructed to drive along the level testing route at a stated speed. He is further instructed that as soon as he hears the blank cartridge fired he is to stop the vehicle immediately. When the vehicle comes to a full stop, he must hold it at that point and not allow it to roll forward or backward.

The test proceeds as follows: When the desired speed has been attained, the stopping-signal switch is thrown by the examiner, unknown to the driver. This fires the first blank cartridge, which signals driver to stop, and places a chalk mark on the road surface (A in

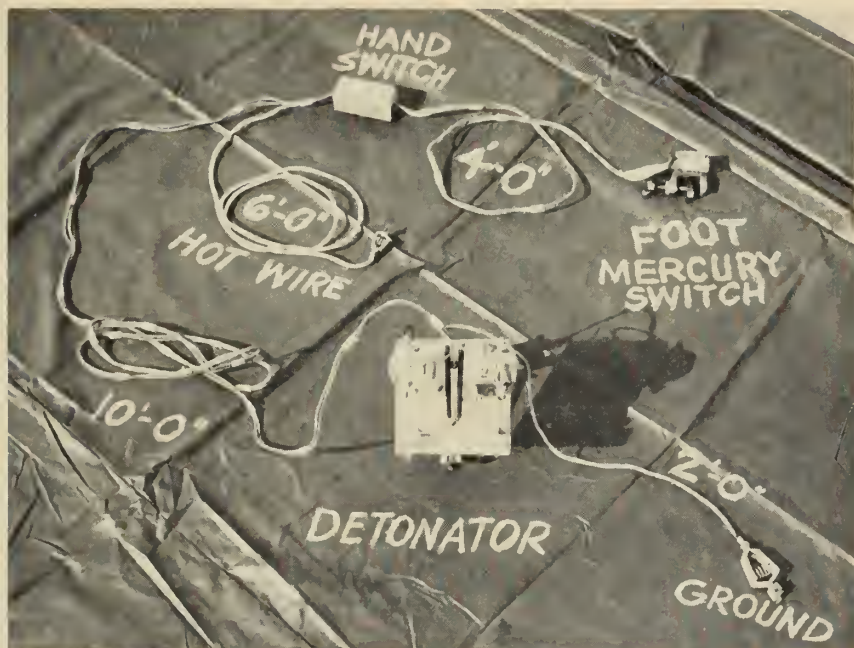


FIGURE 5.—Arrangement and length of wires.

fig. 6). As soon as the driver touches the brake pedal, the second cartridge fires and places the second chalk mark (*B*) on the road surface. When the vehicle is stopped, a chalk mark (*C*) is placed by hand directly under the position of the detonator unit. The reaction distance of the driver is measured between the chalk marks *A* and *B*.



FIGURE 6.—Markings on pavement as made by AAA detonating type brake tester.

The braking distance of the vehicle is measured from chalk mark *B* to chalk mark *C*. Figure 6 shows one driver's marks for 10 miles per hour with the detonator mounted on the vehicle running board.

The following tables, taken from the AAA instruction manual, make it possible to convert the distances for 20, 30, or 40 miles per hour to reaction time in seconds and braking efficiency in percent.

TABLE 1.—*Reaction distance for three speeds by reaction time*

Reaction time (seconds)	Distance between chalk marks <i>A</i> and <i>B</i> , fig. 6, for speeds of—		
	20 miles per hour	30 miles per hour	40 miles per hour
	<i>Feet</i>	<i>Feet</i>	<i>Feet</i>
0. 1	2. 9	4. 4	5. 9
. 2	5. 9	8. 8	11. 7
. 3	8. 8	13. 2	17. 6
. 4	11. 7	17. 6	23. 5
. 5	14. 7	22. 0	29. 4
. 6	17. 6	26. 4	35. 2
. 7	20. 5	30. 8	41. 1
. 8	23. 5	35. 2	46. 9
. 9	26. 4	39. 6	52. 8
1. 0	29. 3	44. 0	58. 7
1. 1	32. 3	48. 4	64. 5
1. 2	35. 2	52. 8	70. 4
1. 3	38. 1	57. 2	76. 2
1. 4	41. 1	61. 6	82. 1
1. 5	44. 0	66. 0	88. 0

¹ Reaction time of average driver is 0.75 second.

TABLE 2.—*Braking distance for three speeds by braking efficiency percent*

Braking efficiency (percent)	Distance from chalk mark <i>B</i> to location of detonator, chalk mark <i>C</i> , fig. 6, for speeds of—		
	20 miles per hour	30 miles per hour	40 miles per hour
	<i>Feet</i>	<i>Feet</i>	<i>Feet</i>
10	133. 6	300. 6	534. 4
20	66. 8	150. 3	267. 2
30	44. 5	100. 2	178. 1
40	33. 4	75. 2	133. 6
¹ 50	26. 7	60. 1	106. 9
60	22. 3	50. 1	89. 1
70	19. 1	42. 9	76. 3
80	16. 7	37. 6	66. 8
90	14. 8	33. 4	59. 4
100	13. 4	30. 1	53. 4

¹ Minimum braking efficiency as allowed by Forest Service Safety Code, 1948, is approximately 50 percent.

This brake tester is an efficient and accurate unit in determining the braking performance of any motor vehicle, as well as definitely ascertaining the distance traveled during reaction time. It is recom-

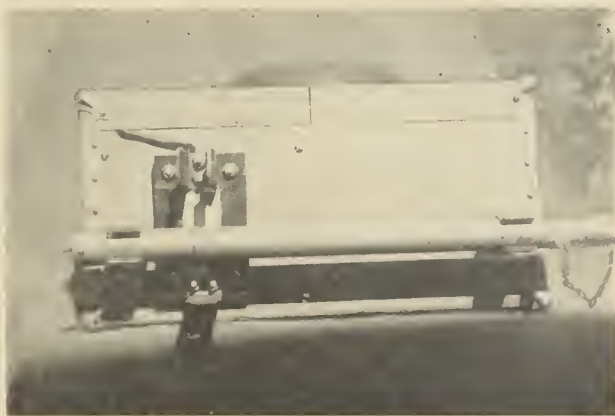
mended that this instrument be used as a regular part of any driver-training or equipment-testing program.

[Federal Government or Cooperative Forest Protection agencies interested in securing this brake tester with the necessary revisions, may purchase the original unit (approximately \$17) from Traffic Engineering and Safety Department, American Automobile Association, Washington, D. C., and send it to Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Drive, Arcadia, Calif., for alteration (approximate cost \$8); or write for further detailed modification instructions.]

Type SX Radiophone Antenna.—Region 5 found the antenna set-up illustrated has increased usefulness of the type SX radiophone set manyfold, especially in fire line work where time and suitable antenna supports are at a premium.

The antenna proper is a war surplus item identified as a type AN-29-C telescopic antenna. It is approximately 13 feet long fully extended. The mounting and upright holding clips are salvaged pump holder clips from back-pack pumps.

The upright holding clips are mounted on a piece of canvas base Micarta insulating material $\frac{1}{2}$ by $2\frac{1}{2}$ by $4\frac{1}{2}$ inches. One clip is mounted toward the top of the block and is electrically connected to the "ANT" post of the SX set. A



Antenna in carrying position.

bottom angle bracket is mounted on the lower side of the block. This lower angle bracket is made by sawing off one lip of a clip, the remaining lip being hammered straight and a $\frac{1}{4}$ -inch hole drilled in it to accommodate the screw mounting stud on the bottom of the antenna proper.

The top clip and the bottom angle support are held on the Micarta block by $\frac{3}{4}$ " x 10-32 flat head countersunk machine screws. The block is fastened to the wood box by four 1" x 10-32 truss head machine screws. The two end clips are mounted on the wood box with $\frac{1}{2}$ " x 10-32 truss head machine screws. A suitable small metal reinforcing plate is also installed on the inside of the box opposite each clip.

Technical adjustment of the antenna loading capacitor within the set proper must be made before putting the antenna into operation.

There are slight electrical deficiencies as a result of mounting the antenna rod as shown; however, this is more than overcome by providing complete portability thus permitting the operator to quickly change locations.—GUY V. WOOD, *Communications Engineer*; D. A. GALBRAITH, *Angeles Radio Technician*; and A. H. SCHOSS, *Stanislaus Radio Technician*; Region 5, U. S. Forest Service.

WE COMBAT FIRE THE COOPERATIVE WAY

J. WHITNEY FLOYD

Chief Forester-Fire Warden, Utah

We've got a habit of long standing in the West. We cooperate. The custom probably grew out of the early experiences of the western pioneers. They had to get together and work together. Otherwise they stood to lose; livestock, household goods, or a scalp. Thus it was second nature for the third and fourth generation of westerners to cooperate in combating fire. Apparently there has always been cooperative action on fires in the State of Utah. But the action was most generally taken as a measure of self- or property-protection until organized fire protection became widespread.

The first opportunity for organized participation came when the Forest Fire Fighters Service was developed under the World War II Office of Civilian Defense. But this cooperation continued after the war emergency was over, and is resulting in an efficient fire organization for very little money. The efficiency and low cost are due to three primary factors.

(1) The cooperative plan reduces duplication of effort where two or more agencies are involved.

(2) The personnel and equipment of all agencies form a pool for common use in prevention, presuppression, and suppression activities.

(3) The cooperative plan appeals to the taxpayer because it demonstrates a united front by all levels of government.

The land ownership pattern of the State, and the nature of its fire control organization, will help the reader in understanding our problem, and our methods employed in its solution.

Utah is a public land State. Seventy-two percent of her total area is federally owned. The largest single Federal landowner is the United States Bureau of Land Management with some 24 million acres, followed by the United States Forest Service with nearly 8 million acres, the Indian Service with 2½ million acres, the National Park Service with 285 thousand acres, and the Soil Conservation Service, Bureau of Reclamation, and others administering a small acreage. The State Board of Forestry is responsible for 6 million acres of forest and watershed land owned by the State, counties, municipalities, and individuals.

Generally the national forest lands occupy the higher mountain areas and are solid blocks, but in a few instances there occur sections or half sections of alien lands. The United States Bureau of Land Management lands are interspersed with other Federal, State, or private lands. Most of the State lands were acquired by educational grants, at the rate of four sections (2, 16, 32, and 36) per township. These remain largely in their original ownership, and are scattered throughout the State, or if they have been sold to individuals

a checkerboard pattern of public and private lands exists. The result of these ownerships is a diversified pattern in many areas, or at least an intermingling of two, three, or more ownerships.

The State forest fire law places the fire responsibility on the county sheriff and his staff in the absence of a county fire department. The State Board of Forestry and Fire Control hires some temporary guards during the fire season, but the fire responsibility begins at the county level. Therefore, in the State we may have, in a given area, from two to seven responsible fire protection agencies, and this, without coordination and cooperation, could result in considerable expense, duplication, and lost effort in fire control activities.

With this situation throughout the State the primary land administering agencies expressed a desire to continue the cooperative working relationship built up during the war. The wartime organization was retained, but we called ourselves the "Utah Cooperative Fire Fighters." Our objective was to give the land in the State the greatest protection at least cost. Our organizational structure was a State committee headed by the State forester with representation from the major land agencies, and a smaller committee in each county, under what we chose to call a county coordinator.

The county coordinator may be a park ranger, a county sheriff, a county fire warden, a Bureau of Land Management district land manager, or a United States Forest Service district ranger. The county coordinator's responsibilities were to bring together all interested agencies on a county level. Each year the State committee outlines and sponsors a State-wide prevention program and training school, to be taken to the counties, or groups of counties. In this way the prevention materials and personnel are so correlated that we have eliminated duplication and intensified prevention.

The results of such a program have been gratifying. Several illustrations will demonstrate this. During 1947 many of the district graziers of the Bureau of Land Management were laid off because of insufficient appropriations. However, numerous fires were taken care of during this fire period by the Cooperative Fire Fighters in those areas, and their fire reports were mailed to the office of the State forester. In another case, the United States Bureau of Land Management had a large fire in Juab County which was threatening Indian land. A neighboring county, Tooele, rushed two fire trucks 140 miles, and they spent 2 days on the fire.

During the fire season of 1948 a lightning fire in Millard County grew to considerable size, burning over State, private, and Federal land. In this particular instance 305 men were quickly mobilized from the sparsely populated counties, and because of the training received through the Cooperative Fire Fighters plan they served as an effective fire force. A good illustration of economy in fire operation is reported in Summit County for the fire season of 1948. The State fire warden reports that 16 fires burned 2,373 acres, and the total suppression cost to the county was only slightly more than \$100. The warden reports that this success and economy was due to the fact that the Utah Cooperative Fire Fighters had trained railroad crews, road and pipe-line construction crews, State road crews, and local ranchers before the fire season started, and these men were available on short notice for fire action.

An interesting phase of our 1948 State spring training program was the zone meetings for key personnel throughout the State. The major theme was law enforcement. The State attorney general's office detailed an attorney who explained the fire laws and law enforcement technique. This seemed to strengthen our State enforcement program for during the past year we had 22 prosecutions and 17 convictions. Only one of these cases was handled by the office of the State forester. The remainder were taken care of by local officers.

Suppression work has been simplified in many counties by the designation of fire suppression responsibilities through the local county committee. A typical example is in Millard County. The United States Forest Service was assigned a suppression boundary which did not necessarily conform to national forest boundaries. The United States Bureau of Land Management district grazer and the county sheriff were each assigned similar boundaries. None of the boundaries conformed to land ownership patterns but rather they circumscribed areas that were most easily seen, reached, and initially attacked by the respective group. Each agency assumed the responsibility of the first attack on fires within their assigned boundaries. The final cost of the fires was to be assigned to the agency owning the land burned. This system decreased detection time, reduced size of fires, and total cost.

Examples such as these have demonstrated to us the economy of cooperation. We intend to continue the system and develop new reserves of mutual assistance. It saves us money and resources.

Blanket Storage.—A heavy three-ply paper bag, similar to a cement sack, was recently put into trial use for packaging blankets at the Angeles Forest warehouse, in place of burlap covering. Ten folded blankets fit into the bag, which is securely closed at the top by two folds through which 8 to 10 Bostitch, Model No. P-2, staples are placed.

Advantages of this method of packaging over the burlap wrapping are as follows:

1. Cheap containers that are disposable. Burlap covering, when returned from project or fire, is always dirty, dusty, or full of foxtails and burrs. Cleaning of burlap is expensive in man-hours or laundry.

2. Time saved in packaging, requiring only one-fourth the time.

3. Containers are dustproof, mothproof, and somewhat rainproof. Burlap covering will allow dust to penetrate when blankets are in storage.

4. Package that will fit into helicopter cargo boxes and also into the automatic cargo release of a helicopter.

5. Package of proper size and shape for horse pack.

6. Package of proper weight for man pack, approximately 40 pounds.

7. Package which is easy to handle and to store.

Packaged blankets are stored in rows and numbered from bottom to top. When shipped from warehouse, the bundle bearing the largest number is shipped first. Thus, the total number of blankets remaining is indicated at all times (namely, the largest number, times 10).

The paper bags can be purchased locally at \$211.40 per 1,000 in lots of 1,000, or \$171.65 per 1,000 in lots of 5,000.

Specifications for bag are as follows: Size, 17 by 12½ by 48 inches; open mouth; three layers—50 substance paper; natural kraft, plain; bottom sewed.—**RICHARD GASPARI, Warehouse Superintendent, Angeles National Forest.**

KAMAS RANGER STATION FIRE TOOL STORAGE BOX

KENNETH O. MAUGHAN

District Ranger, Wasatch National Forest

Fire tool boxes of various designs are widely used throughout the Forest Service with the primary purpose of storing tools so they will be available for anyone needing them. The fire tool box shown makes a practical and well-built cache. It is constructed of the same type material, shingled, and painted to harmonize with the warehouse (white body, green roof), to which it is attached.



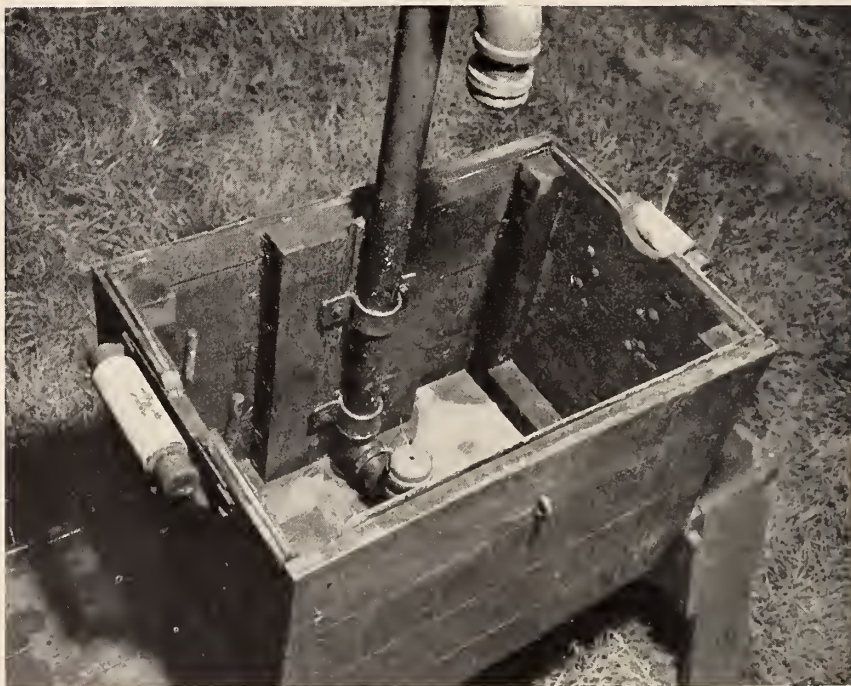
The box is 72 inches high to square, 40 inches wide and 17 inches deep. It is divided into two equal compartments. In one is placed a standard 5-man outfit, in the other a standard 10-man outfit. Tools such as Pulaskis, shovels, and axes are placed on a rack. Rations, files, waterbags, and other items making up the outfits go in the knapsacks.

Each compartment has a separate door, held closed by a simple wood catch. Regular fire seals connect ordinary fence staples driven into the door and into the division board between the two doors so that we may know when the tools have been used and service is required.

Two standard "Fire tool" black and yellow metal signs are used, one on either door to indicate contents of the two sections. The box is not placed on the ground, but is approximately 12 inches above the ground line. This prevents wood decay, makes it handy to get tools in and out, and facilitates keeping the inside of the box clean.

Connecticut Hose Washer.—The Connecticut hose washer was demonstrated at the New Jersey equipment meeting in 1947 and again at Fryeburg, Maine, in 1948. The construction of the washer is illustrated by the photograph.

A wooden frame with a sufficiently wide base is necessary to give stability. Top is hinged for opening to insert hose. Two rolls at front help to guide and flatten hose. Sometimes copper sheets are used as guides instead of rubber rolls. Pipe connections inside box are attached to two hand-made spray nozzles with $\frac{1}{4}$ -inch orifices. These nozzles are set at a sufficient distance above and



Inner works of the Connecticut hose washer.

below line of hose to allow spread of water. Hose is fed through rolls (or copper sheets) between the two nozzles and pulled from opposite end toward drying rack. Generally, a set of bristle brushes is attached to the feed end of the box so that excess mud and dirt may be brushed off before hose enters box. The washer requires approximately $\frac{1}{2}$ gallon of water per foot of hose at 50 pounds pressure to do a good job on dirty hose.—EDWARD RITTER, *Forester, Region 7, U. S. Forest Service.*

LAW ENFORCEMENT IN FIRE CONTROL ON THE CUMBERLAND NATIONAL FOREST

HENRY SIPE

Assistant Forest Supervisor, Cumberland National Forest

The history of forest fires on the Cumberland plateau is similar to that for many Southern States. Before the Cumberland National Forest was created, much of this area was burned over annually. Residents of Morehead, for example, say it was a common form of recreation after dark to drive out on the highways and watch the woods burn. In every community the older people still tell how the woods used to burn "every year." While this is probably an exaggeration, it is an undisputed fact that woods fires were a common occurrence.

Burning the woods in Kentucky was a custom handed down from father to son as being beneficial. It was supposed to green up the woods in early spring, kill snakes and ticks, and clear out the trash. Probably this practice stemmed from the setting of fires by the early settlers for clearing new ground, and eliminating hiding places for Indians. Whether these early practices were necessary or not, we know that they existed.

Such was the situation when the Cumberland National Forest was created in 1930. The first work was, of course, appraising values of lands and negotiating options for their purchase. Soon, however, Civilian Conservation Corps camps were established and fire control work got under way. Suppression was the first fire job done. During 1933 and 1934 no record of the number or size of fires was kept. Crews were sent to any and all fires and helped suppress them. In this way the idea became prevalent in places that the Civilian Conservation Corps would help farmers burn their debris—one hears this thought even now at rare intervals. Of course fire tower, telephone line, and road construction was begun. The enforcement of fire laws—and there were such laws, State and Federal—was not given much thought until 1936. A summary of all fires from 1935 to 1948, inclusive, shows the causes as follows:

Causes:	Fires	
	Number	Percent
Incendiary	717	30
Smokers	638	26
Debris burning	430	18
Miscellaneous ¹	255	10
Railroads	166	7
Campfires	111	5
Lumbering	47	2
Lightning	39	2
Total	2, 403	100

¹ Miscellaneous are chiefly smoking game out of trees, burning buildings or sparks therefrom, or children playing with matches.

One of the conclusions derived from the above figures is that the best way to reduce total area burned on the Cumberland was to *prevent* fires, as contrasted with a reduction in size of the average fire. There has been no significant change in the average area burned per fire in 14 years. This is primarily due to an average elapsed time up to attack of about 1½ hours. It includes discovery, reporting, dispatching, recruiting men, and travel to the fire. As long as we depend on a "volunteer" warden system backed up by a small core of year-long Forest Service personnel, we seem to be unable to reduce this elapsed time. Strangely enough, even during CCC years there was no substantial decrease in average area per fire.

The first fire prevention activity was probably the use of CCC patrolmen to contact local residents in 1934. These were continued until about 1937 when lookouts and wardens and other local employees were assigned the contact job. About 1943 contact work was given exclusively to lookouts or other regular employees, and this has continued up to now. In 1937 a movie project was set up and one man devoted full time to rural showings for a year or two. In recent years movies have been shown sporadically. For 6 months in 1938 a psychologist lived among the people of the forest, posing as a geologist, studying their attitudes and behavior as related to fires and to the general Forest Service program. Since 1936 most other known means of prevention have been used, such as personal contacts, posters, press releases, exhibits, leaflets, radio, and law enforcement.

Fire prevention efforts have borne fruit on the Cumberland. This effort can be divided into general education, hazard reduction, and law enforcement. Education which was begun in 1934 by CCC patrolmen, and enlarged by regular workers in later years, ran into strong adverse sentiment. Many folks were too set in their ways to stop burning the woods or too proud to admit they might have been wrong. It was hard to prove to them how fire prevention could mean dollars in their pockets. Results in the woods seemed too slow. Even today, when farmers are shown how to increase their tobacco income by priming (removing the lower leaves as they ripen before the upper leaves), some are still loath to accept the idea. Education is a slow process at best. And when children are not taught things in school, they will grow into adults faster than forest education can reach them. If parents are unsympathetic, children are inclined to be likewise.

Hazard education has accomplished a substantial decrease in number of fires only along a few railroads, and then only in years and sections when rights-of-way were well fireproofed by burning. This annual burning of sedge grass only makes the right-of-way more hazardous the next year. The Southern Railway is currently cooperating with us in an experiment where the right-of-way is mowed in the fall instead of being burned in early spring. Results have not been conclusive, but I still believe that some other way than burning must be found if the railroad fire problem is to be licked. An important factor is that about half the Southern's locomotives are now Diesels and the L. & N. has several Diesels.

In 1936 a legal assistant was employed on the supervisor's staff; his duty was to push law enforcement. Training schools were held for all regular employees and a law enforcement manual was issued. The objective was to investigate the cause of every fire and take action against the offender. Undoubtedly the bad fire season of 1936 stim-

ulated the law enforcement program, if indeed it did not provide the main urge to initiate such work. With only 2 cases initiated in 1935 out of 185 fires, it is obvious that no program existed prior to 1936. In 1936, out of 71 cases initiated, there were only 20 criminal cases concluded involving 31 persons. Of these, 13 paid fines or went to jail (total of 85 days) for failure to pay fines, and 18 had fines suspended. Only 10 cases were settled by collection of damages. This leaves 41 cases that were to a certain extent "duds." Indictment was refused or they were dismissed after initiation. Sixteen of these forty-one were turned down by prosecuting officials. By present-day rules these 16 fires would not be listed as initiated. Fifty-one letters of warning were written to parties responsible beyond a reasonable doubt for causing fires. This practice of sending warning letters decreased until about 1942 when it was generally discontinued. Table 1 shows certain results of fire control work on the Cumberland since records were kept.

TABLE 1.—*Number of fires and area burned per million acres protected, fire day class, and law enforcement record, Cumberland National Forest, 1935-48*

Year	Per million acres protected		Fire day class			Law enforcement		
	Fires	Area burned	3	4	5	Actionable fires	Cases initiated ¹	
							Civil	Criminal
	Number	Acres	Number	Number	Number	Number	Number	Number
1935	414	3, 357	-----	-----	-----	185	-----	-----
1936	1, 081	19, 335	-----	-----	-----	467	-----	-----
1937	188	2, 532	-----	-----	-----	179	-----	-----
1938	205	1, 671	-----	-----	-----	193	-----	-----
1939	209	2, 123	164	21	2	210	-----	-----
1940	318	4, 173	132	17	-----	321	-----	-----
1941	216	2, 966	121	43	-----	192	17	47
1942	129	2, 082	53	26	-----	126	30	53
1943	97	1, 273	103	25	-----	99	28	28
1944	78	1, 351	83	17	-----	82	28	17
1945	57	858	64	11	-----	56	19	9
1946	136	2, 009	54	16	1	131	19	24
1947	93	1, 426	50	4	-----	89	14	8
1948	79	848	63	5	-----	76	15	5

¹ Cases initiated 1935-40 were not separated into civil and criminal. In 1935, 2 cases were initiated; 1936 71 cases; 1937, 31 cases; 1938, 39 cases; 1939, 40 cases; 1940, 46 cases.

Whether there was adequate preparation for the early law enforcement effort is a question. Although there was general prevention work, it may not have pointed up the probability of law enforcement soon to come. Every campaign to enforce a law must have advance publicity. For example, people need to know when the enforcement will begin, whether first offense penalties will be only a warning by the judge, whether the party responsible may pay the damages through settlement out of court, or whether suspects will be subject to criminal prosecution. All modern public relation methods need to be brought into play.

Forest officers in the early years faced many obstacles. In studying and overcoming them, guides have been established for meeting current situations and for training personnel. It was found that judges and prosecuting attorneys had to be interested in fire prevention and forest management activities. In addition, the voters who elect these officials had to be "sold." Interested judges will usually issue warrants; attorneys will allow witnesses to testify before grand juries; and sheriffs will serve warrants and subpoenas promptly.

Informed officials will see that docketed cases are not dropped or dismissed and that fines are paid, not suspended. Some judges have authority by law to suspend judgments (circuit judges in Kentucky), while others do not (county judges). When a replevin bond is given to pay a fine within a stated period, the cooperative judge will insist on its payment. A defendant will often plead "poverty," and a good judge will recognize that a fine or penalty within the defendant's means will insure that future fires that tend to make the poor poorer will be prevented.

Many fires on the Cumberland have been caused by juveniles. Juvenile judges will cooperate with forest rangers by placing juveniles on probation for a specified period, usually in the custody of the parent. The parent is really the one responsible, but of course cannot be prosecuted for an offense committed by the child. Judges sometimes require juveniles to erect fire prevention posters or write essays on conservation.

It is not essential that a case be "won" in order to accomplish good results. One example of this was a youth who set 17 or more fires along a road one afternoon; the evidence was quite clear. The court officials were not sold well enough in this instance to render prompt action. As the boy was to be inducted into the armed services, the landowner and forest officer secured the warrant and arrested the boy when he came to visit his girl friend. He made bond and slipped off to the recruiting center. However, the grand jury returned a true bill and the Army sent the boy back for trial. After the prosecutor outlined his evidence, the judge allowed a directed verdict of dismissal. There have been no fires in this area in the 5 or 6 years that have since elapsed.

Among the defenses that a defendant will set up, the forest officer must be alert to offset these: (a) he has a job promised to him, if he is acquitted; (b) he is the only source of dependence for an aged and helpless mother; (c) he is feeble-minded; (d) he didn't "abandon" the fire; (e) he "fit the fire" till he was exhausted.

Forest officers must assure themselves that needed witnesses will be at the trial, whether summoned legally or not. If your witness refuses to be sworn or to testify, trouble is brewing. One key witness was murdered before the trial.

The principles and cautions above outlined will be found to be helpful in Federal court cases as well as in State courts. The United States judge and attorney (or an assistant who handles your cases) are key individuals and should be well informed of the forest objectives. The marshal and his deputies can be of great aid in serving papers promptly.

It is essential of course that the law enforcement policy be clearly set forth and understood by all persons who are to place it in effect.

Many employees are as reluctant to participate in legal affairs as is the average citizen today.

One of the important parts of such a policy is to decide the degree to which cases will be initiated. By that I mean, shall cases be initiated only (a) where the party responsible is willing to plead guilty, or (b) where guilt is clear beyond a reasonable doubt, or (c) where there is some question of guilt. It is very desirable to have an "open and shut" plea of guilty case to initiate before a new judge. This allows him to become familiar with the law violated, the possible penalties, and renews his acquaintance with the investigator. After this, more and more difficult cases can be taken before the same judge with more assurance of receiving sympathetic consideration.

Some judges like to handle civil cases and do not like to decide criminal issues. In this event, a judge with concurrent jurisdiction elsewhere in the area may be located. This is true in Kentucky, where magistrates have equal jurisdiction with the county judge.

After an enforcement program has been started, it is essential that it be maintained at a steady and consistent level even though there is a change in personnel. Too often a new ranger will undo the work of several years of steady enforcement.

It is not necessary that all forest officers be highly trained specialists in law enforcement. Give men of reasonable intelligence some training, put the administrative urge behind them, keep up a sustained and persistent effort, and you have the essential elements of a successful program.

In 1942, representatives from important industries and utilities, as well as public employees of major resource agencies, were given training in Army camps to combat sabotage. This training was conducted by FBI personnel and other authorities in their respective fields. The Forest Service selected me as one of its representatives to go to Fort Oglethorpe, Ga., to receive training in such things as complaints, warrants, arrests, searches, investigational methods, various kinds of clues, sources of information, handling evidence, photography, ballistics, sabotage methods, court procedure, admissibility of evidence, and report writing.

Upon my return to the Cumberland, a 3-day training meeting was held at Cumberland Falls State Park for our forest rangers and guards, foresters from nearby forests, and State forest representatives. Most of the Fort Oglethorpe subjects were covered in abbreviated form.

This training stimulated the law enforcement work already begun in the spring of 1942 and resulted in more cases initiated and a good percentage of convictions. In the last year or two the records will indicate somewhat of a let-down. This can be traced to two factors. First, the fires are of the more difficult type to solve. Debris-burning fires—usually easy to solve—have just about disappeared. The bulk of the fires are now hunter, smoker, and incendiary fires—all tough ones. Secondly, it has been difficult to maintain an administrative urge. The war is over, "emergency" measures are not popular, and the timber sales activity is at a peak.

If the number of fires continues to stay below or close to 100 per year, the fire occurrence objective is being met. It is not denied that weather has been on the damp side in recent years. However, one cannot

travel in any part of the forest without being informed by local residents that fires are rare because "folks is a-skeered to let fires get away." (And I say "rare" because the risk on the Cumberland is tremendous. Thousands of people are in the woods much of the time.) Further questioning will usually bring forth the definite claim that the "woods is growing up a lot greener than it used to."

Forest administrators exhibit a wide variation in aptitude and desire when faced with law enforcement. Some just don't like to get into court; a few take to it naturally. Many of the characteristics of a good investigator are also qualities that make for general success in life. For example:

1. A righteous indignation against wrongdoing.
2. Common sense, good judgment, and tact.
3. Aggressiveness and persistence.
4. Resourcefulness.
5. Thoroughness.
6. Observing and good memory.
7. Technical skill and knowledge of the "modus operandi."
8. Familiarity with local customs, dialects, topography, and knowing the people themselves—for example, who lives where.
9. Ability to write a good report.
10. Intellectual honesty.

It is not entirely the fault of unit managers that their law enforcement records are sometimes pitifully poor. Their superiors often turn thumbs down on legal action for fear of stirring up trouble, political or otherwise. Perhaps just as important is the fact that foresters receive very little, if any, law enforcement training in college that would come anywhere near preparing them for the first major test of their professional career in fire control. I cannot agree that this is entirely an on-the-job training subject. I believe all forestry schools should include somewhere in their curricula at least the following subjects:

1. Qualities of good investigators.
2. Methods of investigation (observation and description, interrogation, surveillances, undercover work, and entrapment).
3. Laws and statutes.
4. Equipment used.
5. Clues: footprints, tire tracks, tool marks (especially axes), fingerprints, firearms—exploded shells, etc.
6. Marking, handling, and preserving evidence (for example, making plaster casts).
7. Complaints, warrants, arrests, bonds, summons.
8. Trial procedure.
9. Evidence in court (admissibility, witnesses, what must be proved).
10. Report writing.

It may be argued that it is the prosecuting attorney's duty to handle many of these details for you, and indeed it is. An investigator is likely to find, however, that an attorney who has not been "sold" on your work is more than likely to be on the defendant's side.

Perhaps some examples of the application of science to fire problems will emphasize my points. A bee tree was cut in Rockcastle County and plenty of ax chips were on the ground. The ranger visited the nearby residents, checked chips at woodpiles, tried axes, and soon came up with chips that matched. Considerable thought was evoked in the community, and although the case was not initiated in court for various reasons, few fires have occurred in that area since

then. The owner of the ax maintained his innocence, but everyone in that community knew who got that honey.

In another typical case ax chip marks were matched. The owner of the ax at first denied all knowledge of the affair, but soon admitted that two boys had borrowed his ax to cut down a chestnut tree to smoke out a squirrel. The boys owned up and paid damages.

To properly compare ax marks, chips should be taken from similar wood species and before the ax has been sharpened. Also chips must be taken with right and left hand swings, and with both edges if the ax is double-bitted. Every dent or gash in the edge of the blade will be visible on the top of the chip when it is held so the light throws shadows across the lines.

Occasionally unusual clues will be uncovered. One alert ranger, searching carefully, found a lock of singed hair caught on the root of a stump inside a burned area. Horse tracks led from here to a nearby farmhouse, where the animal was found. The owner admitted riding through the area but denied causing the fire. The ranger obtained a lock of the suspect's hair. Both locks were sent to the FBI laboratory, which replied that they were similar in every major respect. Confronted with this evidence, the suspect admitted he'd been drinking and had fallen off his horse, which ran home. He had then lighted a fire to warm himself; and, when it scorched him, he jumped up, bumped his head on the stump, and left without extinguishing the blaze. He paid a fine in county court.

The laboratory facilities of the FBI stand ready at all times to give expert opinions on all types of evidence. If requested, they will furnish an affidavit. In important cases they will send an expert to testify at the trial. Ordinarily they prefer to assist in field investigations only in incendiary cases and where Federal property is burned or threatened.

One technique every investigator should know is how to make plaster casts. These are valuable in cases involving footprints or tire tracks. Ordinary plaster of paris, obtainable at a drugstore, is sifted slowly into cool water until a thick cream is produced when stirred. This is poured carefully into the track and reinforced with sticks. It sets in 10 minutes or so. It can be removed and, when further dried and gently washed clear of dirt, reveals the track in detail.

Not far from Cumberland Falls tracks of two persons were found near several burned buildings. The fire had spread to the woods. Casts were made which later matched those of two suspects. There had been previous feuding in the vicinity. These parties were brought to trial in State court, but due to "technicalities" the case was lost. However, there have been no more fires in that area.

In the previous case a bloodhound was used to locate the persons who made the tracks. The Cumberland bought two bloodhounds in 1941. One was half foxhound, but could trail as well as the other. In any area where a concerted major effort must be made to curtail incendiarism, a bloodhound will pay for itself. Although easily handled, a dog requires considerable exercising.

In an area where numerous small fires are the rule, I believe it is unwise not to send an investigator either with or before the suppression crew. A crew usually destroys what few clues may have been left by the person who caused the fire; a few acres are saved, but the causative

agent goes unpunished and more fires occur. If a choice existed, it might be better to begin a law enforcement program a year in advance of a suppression organization. This might stimulate local residents to organize really volunteer crews with only nominal outside help.

The Cumberland has a net acquired area of 433,000 acres, but the Federal lands are highly checkerboarded. Thus it is necessary to protect some 524,000 acres of interspersed private holdings. Around the edge of the million-odd acres we protect are other private forest lands. Although a little of this is protected by the State of Kentucky, the majority receives no organized protection.

Undoubtedly the fire influence of the Cumberland National Forest extends beyond the million acres we protect. People are constantly moving from one area to another. This very fact, however, subjects the Cumberland to increased risk. Outsiders, who want to burn carelessly, move in and have to be "educated." Often the education begins only after they have allowed a fire to escape. Our "protective boundary" usually follows some road, stream, ridge, or county line. On adjacent unprotected land, people let fires escape with impunity. As 100-percent fire protection is approached, outsiders moving in will already have been exposed to fire prevention ideas.

It is my contention that every case well handled, regardless of whether it is won or lost—and by that I mean thoroughly and tactfully investigated and prosecuted—will in the long run reduce the number of forest fires.

COOPERATIVE FIRE SUPPRESSION ON THE NICOLET

E. W. ZIMMERMAN

District Ranger, Nicolet National Forest

The district ranger muttered to himself as he turned off the county trunk road onto an old woods road. Why was it the spring fires always occurred in the back country when the side roads were practically impassable? The pickup pumper truck he was driving and his crew of five men could knock down most of the spring fires—if they could get to them soon enough. But that was the catch—after they left the main roads, they had to travel soft, slippery roads with high centers and panbusting boulders. He had requested a high-clearance, four-wheel-drive truck for just such conditions but those things take time.

Just ahead was a particularly bad looking piece of road. It was some distance to the fire and they had to get a lot closer if the pumper was going to be of any use to them. He gunned the motor and plunged into the mudhole. The truck slid to the side and promptly came to a stop as the rear wheels dropped into a deep rut. Sure enough, they were stuck. The crew jumped out and began to block up the wheels as the ranger gave the dispatcher a call on the radio and advised him of the situation.

After 30 minutes of hard work, they were able to get the truck through that mudhole and the one just beyond. The ranger was anxious. With this wind and all the elapsed time, they would without a doubt have a class C fire by the time they arrived. The old road turned and ran along side the railroad track and they could see the fire up ahead. This must be a railroad fire, but it seemed very small and certainly wasn't moving at the rate the ranger had expected. Luck must be with us, he thought, considering the excessive attack time we are very lucky indeed; but wait, there is a man working on the fire, beating it with a pine top—there's another man—and another—all beating at the fire with great vim and vigor.

The ranger and his crew jumped out to help the three-man crew already on the fire. In a few minutes the fire was under control. The area burned was small. The ranger knew these men, a local farmer and his two sons. They had seen the smoke from their east field where they were plowing and had cut straight across country to the fire which was not more than an acre in size when they arrived. They expected no compensation for their work as they felt they were protecting their own property as well as that of the Forest Service, and then too, they did not want to see that young plantation burn—the one the Forest Service planted some years ago about a quarter of a mile north.

The ranger was grateful because, as he looked over the surrounding area, he realized this fire could have developed rapidly and become a project fire if the farmer and his sons had not been close and had not taken immediate suppression action.

This free will initial action is typical of the cooperative fire suppression which takes place on many ranger districts every season. Yet, this extremely valuable form of cooperation can be greatly enlarged to the everlasting benefit and protection of our timberlands. Enlarging a program of this sort presents many difficulties and discouragements; not the least of which is the practice, created through necessity, of paying for all fire fighting work. We cannot avoid hiring men for fire suppression work, nor can we anticipate the complete and over-all control of fires by cooperators. To approach even this glorious ideal is more than we can expect from local people who have their own lives to lead. Then too, there are some who will ask, "What's in it for me?" Have we an answer which will satisfy these individuals? Lack of local settlers in critical areas limits the possibilities on some districts.

In spite of these and other unfavorable aspects, there must be ways and means of increasing the amount of cooperative fire suppression. It would seem that we should lay the ground work in advance—that we should make a particular effort to build good will among the settlers in isolated areas. Here again we face obstacles; district personnel is subject to frequent transfer and, to a lesser extent, settlers move from critical areas and new people move in.

The proposed good-will program involves time, effort, and education. Ours is the task of convincing the district residents that they have enough at stake to justify their taking time to put out small fires. We have come a long way in our program of showing people they have enough at stake to *prevent* fires; now we must ask them to go a step further. Cooperators gain a source of satisfaction from doing a service to the community. Our job is to foster and develop this feeling and to see that these individuals gain recognition for this service. The task is not simple. The human struggle for the material things of life does not parallel our purpose, nor can we develop an efficient corps of cooperators overnight, but the ultimate goal is well worth striving for.

AIRCRAFT IN FOREST FIRE CONTROL IN NEW YORK¹

F. C. McLANE

New York State Conservation Department

Someone said once that "Time is the essence and custodian of all experience." Time, relatively speaking, is just as important a factor to the business of forest fire control as it is to our daily lives. In this forest fire control business we have formulas for calculating the rate of spread of a fire; for calculating its probabilities; for calculating the number of men needed to check its advance in a given period; for estimating the damage done; and for many other things. We have factors and equations entering into problems of fire behavior; methods of attack; fire line construction, mechanical and otherwise; etc.—all necessary to do the best possible fire suppression job. But when it comes down to the final analysis, the result of our work, whether good or bad, is dependent primarily on time.

Naturally, then, the speed and accuracy with which we do things has a definite bearing on the conservation of the time element. Specifically, the modern plan of forest fire control is founded on speed. It is designated to reduce, insofar as possible, the most dangerous factor: lapsed time—the interval between the inception of a fire and the time that actual suppression measures may be undertaken. To reduce this time to a minimum, we must be constantly on the alert to develop and adopt new techniques and equipment, and to devise suitable and efficient ways to use them. The struggle against lapsed time begins with the prompt and accurate detection and reporting of a forest fire, and is followed up by promptness in dispatching fire suppression crews and equipment to the scene of the fire.

Many new devices have been adapted to modern forest fire suppression and great advances have been made in the development of forest fire control equipment in the past decade. One of these time-saving developments is aircraft.

We purchased our first airplane back in 1931, and since then we have used our aircraft to what we believe to be the best possible advantage, amassing nearly 15,000 of the roughest, toughest, and nastiest flying hours. Flying was done under all conditions and, up to 2½ years ago, with one, single-engine airplane that was replaced periodically. We feel justified, also, in being proud of our safety record.

The first airplane was used in systematic patrol for the detection of forest fires. The initial patrols were made in a fire control district lying southeast of the Catskills and at the back door of Metropolitan New York City, because the detection system there was inadequate, and nearly 25 percent of all the forest fires in the State were occurring there at that time.

¹ Condensed from paper presented at a meeting of State fire protection officers, Bearbrook State Park, N. H., March 17, 1949.

The results of the first year were encouraging. It became increasingly evident that aircraft had possibilities of fitting into any situation where time, distance, or transport entered the equation. But its use was definitely limited because of lack of air-to-ground communications. This missing link was supplied in the following year, 1932, by the installation of two-way radio. With each ensuing year, the airplane achieved greater success in the reduction of fire losses. As our airplane was replaced from time to time by new and improved types, new uses were developed. Most of these developments were spectacular at first. Today, aircraft has become one of the most effective tools in the hands of our forest fire control organization. It fits solidly into our plans and is a definite "must" if we are to keep abreast of modern fire control developments.

We don't know all the answers to our fire control aviation problems. On the other hand, we feel that in 18 years of using aircraft in forest fire control we have acquired a background of considerable experience in the application of aircraft. What we have determined to our own satisfaction is—

1. That we have only scratched the surface, as far as the use of aircraft is concerned.
2. That there is plenty to be accomplished.
3. That certain, specific types of aircraft are more adaptable for certain assignments than others.
4. That no one piece of aircraft equipment available on the commercial market today is ideal for meeting the variety of complex fire problems we have to cope with in New York State.
5. That the airplane is a fast and adaptable piece of machinery, necessary for effective forest fire control.

What have we done with our aircraft, in these 18 years of operation, that has made it such an important cog in our forest fire control machinery? These activities fall into nearly every phase of forest fire control including prevention, presuppression, detection, reporting, suppression, scouting, and the estimating of burned areas and damage. Suppose we make a quick analysis of each of these seven phases.

Prevention.—The airplane has a definite psychological value in the areas in which it operates. The attendant radio and newspaper publicity, coupled with the airplane flying overhead, makes people surprisingly forest fire conscious, especially in areas where fire permits are necessary. In this connection, I have heard a responsible State official who witnessed this phase of operation say, "The airplane is the most effective single forest fire prevention medium in effect in New York State today."

Presuppression.—Strong presuppression action, so as to catch fires when small—rather than greater suppression action, aimed primarily at keeping 10-acre fires from becoming 200-acre fires—is one of the cardinal principles of our forest fire control organization. The airplane plays a part, directly or indirectly, in most of our presuppression planning. The patrolling of State land and areas where fires are numerous, with an eye for such things as logging operations, blow-down areas, etc., helps tremendously in compiling current slash maps or maps of high fire hazard. Registration of intended cutting by lumber operators is not required in New York State, consequently many logging jobs are well under way adjacent to and outside our

forest preserve before we are aware of them. Obviously, the degree of fire hazard depends on the size of the job and its location. Slash maps and maps of high fire hazard are of major importance in planning appropriate suppression action when a fire is reported.

In remote areas of probable fire hazard the construction of proper facilities for storing fire fighting tools and housing personnel is one of our presuppression measures. Four such buildings were strategically located in our forest preserve, and we had the occasion last fall to erect another on the shore of a small lake in a very remote section. It was necessary to transport 20 tons of materials 22 miles to do this job. Twenty-three trips by plane in $3\frac{1}{2}$ days moved everything. Each round trip, including loading and unloading, averaged 55 minutes. At the loading point, trucks backed up to the airplane. The unloading point was just 60 feet from where the building was erected. It would have taken a tractor and jumper, with maximum possible load, 132 days to do this job. Figuring tractor hire, labor, time, weather, etc., we determined that with our Grumman "Goose" amphibian we did this job in one-fortieth the time and at one-half the cost.

Detection.—In my opinion, the airplane will never entirely replace the highly developed tower detection system we have in New York State today. This has been borne out, not alone by our own experience, but also by the experience of the Civil Air Patrol on forest fire detection during the war. On days when visibility is definitely restricted because of haze, smoke, etc., our single-engine "Navion" is of definite value in detection. In these cases, we are able to eliminate tower guesswork by definitely establishing the location of a fire.

Reporting.—We can pinpoint the location of a fire, size it up as of that minute, and give by two-way radio pertinent information such as size, rate of spread, strength of attack needed, where water (if any) is available, location of natural barriers, etc. We can make an immediate appraisal of its probabilities and, if necessary, organize follow-up attack strength, even before the initial crews arrive at the fire.

Small smokes deep in the forest are investigated and reported. Some of these smokes demand immediate suppression action. In many cases investigation has proved these smokes to be safe camp fires, and many a forest ranger and crew has been spared the task of carrying heavy fire fighting equipment many a weary mile on a false alarm. When a ranger leaves for a fire there is no satisfactory way of knowing where he is or what's happening to him unless he is equipped with radio. Obviously then this is not alone a saving of time, money, and effort, but, just as important, that ranger, with his crew, is not "lost" at a time when, perhaps, he may be needed most.

Suppression.—Speed of attack is our keynote. It is a major factor in the progressive reduction of fire losses. In actual suppression we are able to guide the fire fighters directly to the scene of the fire, and, in many cases, direct the actual initial attack. We are able to control men and equipment at all times, whether en route or actually working on the fire line. We can concentrate all forces on one fire or divide forces to take care of several fires as the occasions and conditions warrant. All this is effectively accomplished from aircraft because of the commanding view of the situation. It has its psychological value too, because the men on the ground know that the

airplane is watching out for everything, including fires in other parts of the district. One swing around any fire and there are no loafers on the fire line.

Transportation of supervisory personnel and equipment quickly from one fire to another or from one end of the State to the other is extremely valuable, especially for large fires. As a matter of fact, we transported personnel and equipment to one 10,000-acre fire and thereby saved the lives of 15 persons. Actually, if it is a matter of equipment only, we can deliver hand tools and power pump accessories, including gasoline, by dropping them directly on the fire line. We are furthering our cargo parachute dropping project this year.

Scouting.—Reports on the current progress of any fire is of paramount importance to the men in charge on the ground. These reports can be quickly and easily made from the air. They include calculating rate of spread; informing crews of outbreaks along the fire line, etc.; locating spot fires as they occur and guiding crews to them; and, patrolling the fire after it is under control. In this latter category, it is our general practice to make early morning patrols to catch outbreaks on the line before the heat of the day has its effect.

Estimation of Burned Areas and Damage.—To say that we are able by airplane to estimate burned areas and damage usually within 5 percent may sound fantastic, but it is nevertheless true. The method of estimating is based on actual surveys on the ground. Our largest recorded error in 12 years of using this system was slightly over 6 percent on a 690-acre fire.

Any study of our modern forest fire control methods may well take into consideration the American tempo, the eternal quest for doing things quicker and more efficiently, as typified by our efforts to "streamline" our living and working conditions. This pace is reflected in our forestry practices, our watershed management, and our recreational habits. All this has a profound effect upon forest fire control. Today, we are called upon to fight fires which are directly the result of this American tempo; fires which demand of us the promptest kind of response and the use of specialized apparatus and equipment, such as high-speed water-carrying trucks, power pumps, ditch diggers, fire line constructors, airplanes, and parachutes, that might never have been dreamed of even by a "Jules Verne" of our original forest fire control organization.

The use of aircraft in forest fire control in New York State has been tried and proven. Each year adds to our experience with, and knowledge of, this use of aircraft and to our dependence on it. However, we are still not making fullest possible use of aircraft. This will be our goal in the near future. Who knows but that in the not-too-distant future foresters, even those who doubted the value of aircraft, may be directing the actual attack on a fire from behind desks 100 miles away, through the medium of aircraft, radio, and television.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

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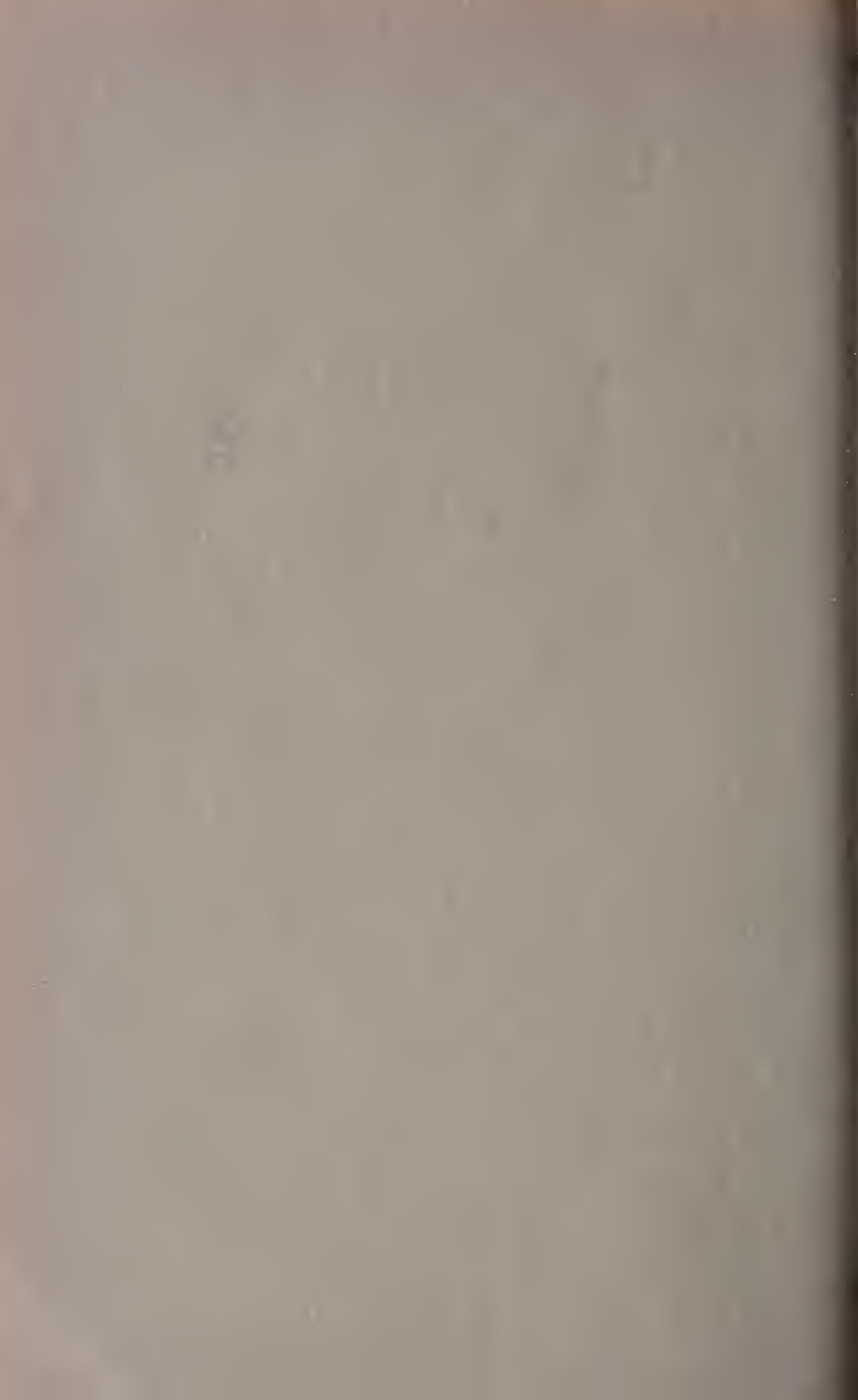
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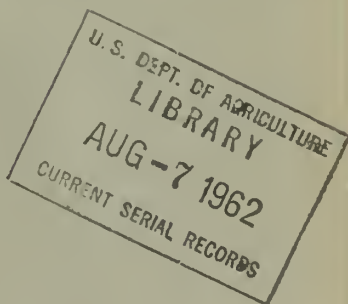
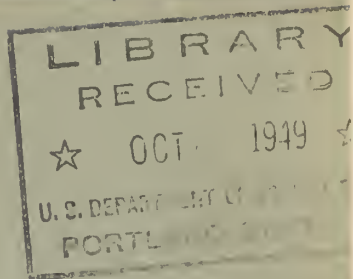
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FIRE CONTROL NOTES



A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FORESTRY cannot restore the
FAmerican heritage of natural re-
sources if the appalling wastage by fire
continues. This publication will serve as
a channel through which creative devel-
opments in management and techniques
may be communicated to and from every
worker in the field of forest fire control.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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BROADCAST SLASH BURNING AFTER A RAIN¹

ROBERT AUFDERHEIDE AND WILLIAM G. MORRIS

Pacific Northwest Forest and Range Experiment Station

Slash burning after clear cutting in the Douglas-fir region has been previously discussed in pamphlets published by the Oregon State Board of Forestry, Washington Forest Fire Association, West Coast Lumbermen's Association, Western Forestry and Conservation Association, and the United States Forest Service and in several trade journal articles. The authors claim no originality for the material in the following article but believe the points discussed are worth reconsideration. Some of the suggestions will probably be new to readers who have not closely studied the methods of slash burning used in different parts of the Douglas-fir region. The origin and adoption of the policy to burn slash as soon as it becomes inflammable during the clearing weather immediately after a rain instead of waiting until just before the next rain is expected has not yet been definitely dated. The State Forester of Oregon states that his organization has followed it in the Douglas-fir region for a number of years. Several of the national forests in the Douglas-fir region have followed this policy in recent years.—*Ed.*

Broadcast burning of slash in the Douglas-fir region is often done just before an expected heavy fall rain. If the rain occurs in sufficient quantity at the right time, no work is necessary to confine the fire to the slash area. If the expected rain does not occur, it is often difficult to confine the fire to the slash area. Furthermore, burning just before



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A slash fire burning with moderate intensity when the ground is still moist from a preceding rain leaves unburned beneficial humus in the topsoil.

¹ Reprinted from the September 1948 issue of *West Coast Lumberman*.

a rain is open to other criticisms. In contrast, recent experience shows that burning after a rain, as soon as slash is dry enough, has several advantages.

The forestry objectives in burning slash are: (1) To remove flashy small material in which dry-weather fires spread with such speed and heat that they can seldom be controlled inside of the slash area; (2) to burn apart crossed and closely lying logs, separating them where great heat can be developed and thus make an accidental fire more



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When the weather begins to clear after a rain, slash in a clear cutting will be come dry enough to burn while the litter in the green timber is still moist.

intense and difficult to control; (3) to check the growth of brush that sprouts from roots established before logging and competes with tree seedlings; (4) to remove excessive debris that would prevent tree seeds from reaching a suitable seedbed; (5) to accomplish as far as possible the foregoing aims without scorching adjacent standing timber or causing undue heat injury to the soil and seed trees within the slash area.

ADVANCE PLANNING

With such objectives, slash burning helps keep forest lands productive. It is not just a clean-up job to be done after the cutting under any conditions the operation may create; it is an important part of the cutting operation and, like other phases, should be efficiently coordinated. Plans for broadcast slash burning should be started long

before the burning season. Some of the greatest difficulties and risks can often be eliminated if the slash-burning job is carefully considered in the cutting plans.

Good planning will avoid the following difficulties and risks: (1) Slash areas too big to be burned in 1 or 2 days by firing successive narrow strips along the contours, beginning at the top of the slash area. A slash fire that runs unchecked a long distance up a slope usually creates excessive heat. (Staggered settings of 80 acres or less facilitate slash burning, especially when periods of good burning weather are short.) (2) Equipment and logs situated alongside considerable slash with no firebreak to isolate them at the time of the first burning season. (3) Current slash joined with that of another owned. (4) Tops felled into the adjoining green timber. (5) No firebreaks, such as ridges, streams, rock outcroppings, or roads, around the slash.

Advance work should also include a detailed plan of the burning jobs, outlined on paper well ahead of the burning date. This should provide: (1) A description of the weather and fuel moisture conditions desired. (2) Desirable time of day to begin setting fires. (3) A sketch of the area showing topographic features, boundaries of the area to be burned, and the order in which different parts of the fire will be set if the prevailing wind direction for the locality occurs. An alternate order of setting for another wind direction may be desirable. (4) Number of men needed to do a good job, and their specific assignments. (5) Estimated length of time to set the fire and to patrol and mop it up. (6) Number of torches, amount of oil, and other firing equipment. (7) Placement of portable pumps and tank trucks for fire control use. (8) Hand tools and bulldozer (on the job) for emergency use. (9) Communication and arrangements for extra fire control help if needed.

Finally, two parts of the slash-burning job should be done, if possible, before the burning season. All snags inside the slash area and any outside but near the area boundary should be felled. A fire trail should be built along adjoining cut-over areas, certain open types of standing timber, and other critical edges. The decision on the need for advance fire lines will depend largely upon the nature of the slash, the topography, adjacent timber conditions, and availability of adequate manpower for mop-up. Bulldozer fire lines, particularly on sidehills, have the disadvantage of mixing much dirt with the slash to be burned; this causes fire to smolder a long time on the edges of the slash area. If a bulldozer is used, the dirt and debris should be pushed away from the slash area to avoid a smoldering fire at the line.

CHOOSING THE SLASH MOISTURE CONDITIONS FOR BURNING

Since one objective of broadcast slash burning should be to avoid undue heat injury to the soil, seed trees, and adjacent timber, the soil should be moist in both the slash area and adjacent areas. Yet to allow economical fire setting the fine material should be dry enough to carry fire and be easily kindled. In the light of these requirements,

fall burning just before an expected rain presents several disadvantages:

(1) The soil, duff, and logs on the slash area will usually be dry. Such slash generally burns too intensely, and a hard burn is destructive to soil structure, soil humus content, and seed trees.

(2) If the slash is very dry, the adjacent areas also will be dry. Under these conditions, numerous spot fires and break-aways can be expected; this increases the cost of control and causes loss of adjacent timber, equipment, or other values. Even though timbered areas may be fairly damp, the exposed edges for several hundred feet inward may be almost as dry as the slash area. Hemlock and spruce, which are particularly susceptible to fire damage, will die from the effects of a ground fire around their bases.

(3) The timing and intensity of a rain storm in a given small area are difficult to forecast.

(4) Most storms are preceded by strong winds; this will increase the danger of break-aways and damage.

(5) If the rain begins sooner than expected, there generally is an urge to fire the slash rapidly. When this happens, a hard burn is the usual result, and frequently uncut timber around the edges is scorched. Sometimes the slash quickly becomes too wet for the set fires to spread. Instead, they smolder and burn in the concentrations without completely dying out; real danger may occur later with a change to low humidities and increased wind velocities.

(6) The expected rain may not occur. A serious fire problem may confront the burner in this situation, depending upon adjacent timber conditions and subsequent weather.

TREND SINCE 1942

Since about 1942 there has been a trend toward doing fall slash burning immediately after a rain. This method has definite advantages in avoiding heat injury and providing good conditions for burning:

(1) As fast as the fine slash and surface of the coarse slash become dry after the rain, the slash is burned. Since the duff is still wet below the surface, it is completely burned only in the spots beneath logs or piles of hot burning fuels. On the remaining area the fire destroys the light and flashy fuels but dies out before consuming the duff and humus in the soil.

(2) The fine slash will dry out first while the fuels in the adjacent green timber are still wet. The wet duff and damp litter in the timber will lessen the danger from spotting and break-aways. In many instances when slash is burned under these conditions, advance fire lines are unnecessary.

(3) The first few clear days following the rain are usually calm and offer ideal conditions for controlling the burn.

(4) The materials in which the fire spreads can be burned out before dangerous weather develops.

(5) Under this method it is possible to do the slow burning that does the least damage to forest soils, seed trees, and surrounding timber. More time is usually available for setting the fire in successive

contour strips down the hill. This avoids a sweeping and excessively hot fire.

(6) Where one person or one crew has responsibility for burning a number of slash areas, this system offers a longer period in which to do the job. In this way experienced slash-burning personnel can cover more ground, and better burning results are probable.

In any broadcast slash burning, good judgment in picking the right time to burn is essential to success. The decision on whether to burn early or late in the season will be determined by the general location of the slash area and the burning conditions on and adjacent to the slash area.

WAIT UNTIL 3 INCHES OF RAIN

Burning after a fall rain should not be attempted until about 3 inches of rain have occurred. This will usually be after two or more storms. There should be reasonable certainty that timbered areas will not again dry out that year. Fall rains occur at varying dates and usually begin earlier in the northern part of the Douglas-fir region than in the southern. Coastal slopes also become wet earlier than inland areas. Good burning conditions ordinarily occur in inland areas between October 1 and 20, and along the coast between September 10 and October 1.

A large slash area adjacent to other highly inflammable areas is more dangerous to burn early in the fall than a small slash area surrounded by green timber. Where high-risk burning chances occur, it is advisable to burn late. However, good slash-burning results cannot be expected consistently on such chances regardless of the time of burning. By planning the logging operation well, however, many of the risks can usually be eliminated or minimized. The poor slash-burning results obtained on most dangerous slash areas happen largely because management permits difficult situations to occur.

In stream bottoms and on north slopes on the coast fog belt where dense brush grew before logging, slash should be burned fairly early in the season after the first fall rains occur and under fairly dry burning conditions. This is done to obtain the best possible regeneration of conifers. One purpose of such burning is temporarily to set back the brush in order to give natural regeneration or planted stock a chance to become established. The coastal brush is more of an obstacle to adequate natural reproduction than is commonly appreciated. Unless burned with sufficient heat to kill the tops and injure the root crowns, this brush springs up rapidly when exposed to full light following logging. It will then hold the area it occupies and exclude conifer seedlings.

THE DAY TO BURN

It is advisable to burn as promptly as possible after the rain—as soon as the small materials and log surfaces have dried enough to ignite easily and while the lower duff layer in the slash and all fuels in adjacent timber are still damp. In selecting the best day, the dampness of the duff should be determined at several points in adjacent timber and in the area to be burned by digging into the duff

with the hands. The inflammability of fine fuels can be estimated by the brittleness of twigs. A better method is to burn a small sample of fine slash. If the fire will not spread, burning should be discontinued until conditions improve. Best results are obtained when the fire spreads slowly and many sets are required to ignite the entire area.

Even though the relative humidity is low, the fire can be easily managed if the air is calm and the duff is moist. Successful, controlled, nondestructive slash fires have been observed burning under these conditions shortly after a rain when the relative humidity was only 25 percent.

Weather Bureau forecasts should be studied before burning and also after burning is under way. The Weather Bureau wishes to assist with slash-burning projects and is glad to provide fire-weather forecasts.

SETTING THE FIRES

In setting the fires the most dangerous edges should be lit first and a safety strip should be burned around areas to be left unburned. Topography, and condition of the slash should be considered in the firing progression. In all cases the uphill and leeward sides of the area should be fired first. It is best to proceed slowly at first, and edges should be well burned out before setting additional fires. Hot, destructive burning can result from setting off too much area at one time.

Once started, burning should be continued until all fuels within the slash area have been ignited, but burning should be discontinued whenever set fires will no longer spread. Smoldering fires scattered through a large area of unburned fuel are apt to produce an undesirably hot fire when burning conditions become more severe during the afternoon of the next day. To avoid this circumstance, it is also advisable to delay setting more fires until about noon the next day or until such a time as they will spread. Frequently, excellent results can be obtained by burning south slopes and dry exposures during the early part of the night, and north slopes, creek bottoms, and other damp areas during the heat of the next day.

MOP-UP

The importance of mop-up to continuing success of slash burning after a rain cannot be overemphasized. In burning immediately after a rain, dryer weather can be expected. After the slash fire has cooled, any live edges should be trailed and mopped up. The proper time to do this mop-up is while weather and fuel conditions are still favorable for moderate burning. The objective should be to have the edges of the burned slash dead before dangerous weather conditions occur. If the slash has been properly burned under the right conditions, a clean burn will be obtained, and not much live edge will remain 24 to 36 hours after the slash has been fired. A clean burn properly mopped up will not spread fire even though the weather becomes dangerous.

Those who have tried this method for a number of years claim that the results are achieving the objectives of good slash burning with less trouble, loss, and expense than burning before an expected rain.

FIGHTING LIGHTNING FIRES ON THE KLAMATH NATIONAL FOREST

T. A. BIGELOW, *Fire Control Officer*, and A. L. MORFORD, *Dispatcher*,
Klamath National Forest

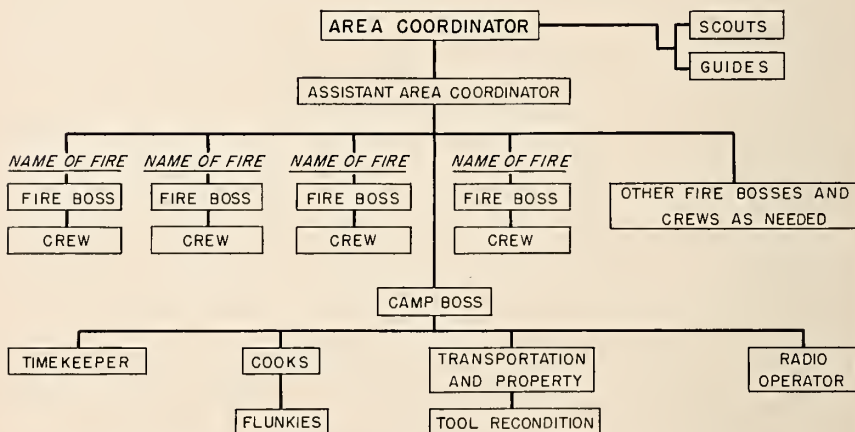
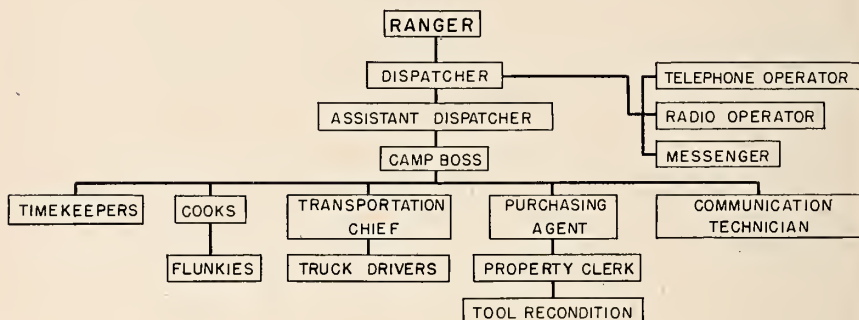
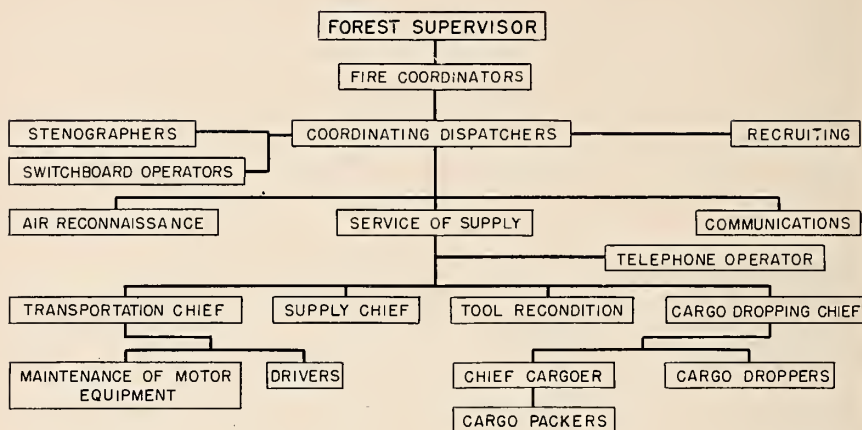
One look at the burned-area map of the Klamath for the period 1910 to 1920 and you immediately ask, "What on earth caused such a widely scattered burned-area pattern?" The size of these burned areas indicates a tremendous loss in natural resources to the State and Nation. A quick glance at the statistics reveals the answer, 100 to 150 lightning fires per year. If you follow the records on through the next decade you will observe the same burned-area pattern, except a slightly heavier concentration around the more or less inhabited areas. The same number of lightning fires appear as before, but to it is added a new problem, incendiary sets, most of them set at the same time. It is quite apparent that the Klamath's fire problem is not the occasional single man-caused fire, but rather many fires occurring from lightning and incendiarism at the same time.

The development of a system to handle these concentrations of fires was begun in the 20's and further developed during the 30's. The early 40's saw a well-established method perfected and used to a marked degree of success, reflected in the highly desirable reduction in burned area. However, the average number of lightning fires per year showed some increase, probably due to the success of reaching more fires before they burned together, causing the larger burned areas shown in the early history of the Klamath. A description of the system follows.

In order to handle from 75 to 100 fires, occurring within a 2- or 3-day period over an area of 1,600,000 acres, it is quite necessary to operate under a decentralized plan with a highly trained officer to coordinate the action between the various district headquarters. The supervisor's headquarters organization to coordinate and furnish the service of supply necessary to the districts and the ranger's headquarters organization are shown on the chart.

The fires usually occur in groups of 3 to 8 that logically can be handled from a central point of operation. We have elected to call these coordinating areas, which are under the direction of an area coordinator, who has two distinct types of organization under his command: The first, fire bosses and fire fighters, and the second, service and supply.

This system operates as follows: The lookouts report all fires to the district dispatcher, who locates them and then passes the location on to the area coordinator, who sends out a fire boss and fire fighters. These fire fighters are serviced and supplied by the area coordinator's serv-



Organization chart for forest supervisor, ranger, and area coordinator.

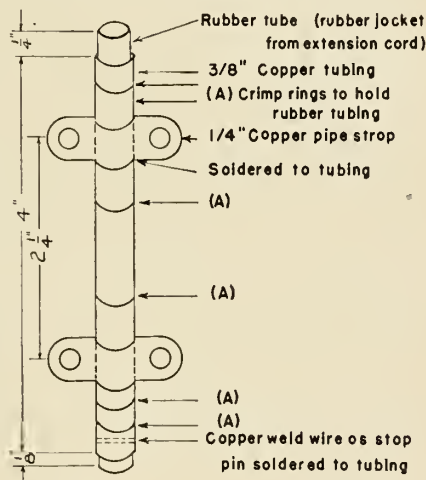
ice of supply organization. The district headquarters organization furnishes overhead labor and supplies, as requested by each area coordinator. The supervisor's headquarters organization provides the same service of supply to the district headquarters.

The chart indicates the organization which is to handle the maximum fire load. Each division of the organization is built up as the size of the job increases. In other words, the coordinating dispatcher and the warehousemen would probably handle the job for the supervisor, the district dispatcher for the ranger headquarters, and the coordinator with a few fire fighters would handle the beginning of a concentration, directing all of the activities which are indicated under them on the charts. As the needs increase, the organization is gradually built up to keep abreast of the size of the job by adding individuals to handle the various services.

Antenna Safety Holder.—The prescribed method for holding down a whip antenna, by merely placing it under a hook mounted at the rear of the roof on a sedan presents a serious safety hazard to a person's eyes when opening the car trunk.

A simple yet highly efficient solution to the safety problem is shown in the accompanying drawing. The holder consists of a piece of rubber-lined copper tubing attached to the roof of the vehicle by means of sheet-metal screws. The tip of the antenna rod is pushed into this tube and is held in place by the thrust of the steel rod when bent. Since a positive connection is not used, the antenna rod may be pulled out if struck by an overhanging tree limb or other obstruction.

In the case of pickup and stakeside truck installations the tube (without the pipe strap holders) is attached to a chain or thong which, in turn, is fastened to the side of the bed or guard rail of the vehicle.—JOHN H. WEST, *Forest Engineer*, and CHARLES E. BELL, *Radio Technician, Six Rivers National Forest*.



WILL EXHAUST GASES HELP PUT OUT FIRES?

T. V. PEARSON

Administrative Officer, Forest Service, Washington D. C.

One gallon of ordinary gasoline vaporized at 100° C. (212° F.) occupies a volume of about 195 gallons. About 90 pounds of air (9,000 gallons) is used to burn the vapor from 1 gallon of gasoline, assuming perfect combustion without excess air. Such burning in an average auto engine produces about 96 pounds of exhaust which, cooled to ordinary atmospheric temperature, equals about 1,300 cubic feet (9,750 gallons). This exhaust is composed of 14.8 percent carbon dioxide and 85.2 percent other inert gases, principally nitrogen, all enemies of fire, with only traces of oxygen, carbon monoxide, methane, and hydrogen.

Exhaust gas usually leaves the exhaust pipe at a temperature considerably higher than atmospheric temperature, therefore the volume at the exit may be as much as two to three times as great as the 1,300 cubic feet quoted.

Some simple trials were made in the summer of 1946 to observe the effectiveness of hot exhaust gas in smothering small test fires. The exhaust gas from a small sedan engine burning 1 gallon of gasoline in about 30 minutes registered roughly 500° F. at the exhaust exit. This was applied through a 50-foot flexible metal hose. At the exit of this hose tests showed the temperature to be about 300° F.

1. One quart of gasoline was sprayed on a tree trunk to a height of 6 feet and ignited into a roaring flame. Careful application of the exhaust gas extinguished the flame in about 12 seconds.

2. One quart of gasoline was splashed on the outer wall of a garage and ignited. The roaring flame was extinguished in about 18 seconds by application of the exhaust gas.

3. A teacup of gasoline was poured into a 12-quart bucket and ignited. The flames were smothered by the exhaust gas in 4 seconds.

4. One-half gallon of gasoline was sprinkled on a 10-foot square surface of hard clay soil and ignited. The flames on the full area were extinguished by the exhaust gas in about 20 seconds.

5. An actively burning fire in a pile of kindling wood 2 feet in diameter was extinguished by the exhaust gas in about 35 seconds.

6. A line of fire in dry oak leaves on a forest floor was extinguished by the exhaust gas at a speed of a slow walk.

7. A line of fire burning in 5-inch dry grass was extinguished by the exhaust at a speed of a slow walk.

8. A cup of gasoline was sprinkled on the auto engine and ignited. The exhaust gas extinguished this engine fire in a few seconds.

9. The exhaust gas was applied to a large bonfire with only little effect. Flames in limited sections were extinguished, but following the application of the hot exhaust gas the flammable gases from the wood mass were repeatedly ignited by the heat from nearby hot coals. *The method therefore would fail in heavy fuel because the hot gases do not reduce the temperature of the fuel below its kindling point.*

Thus we have some evidence that hot exhaust gas undiluted with air, or diluted with that amount of cold air which will limit the oxygen content of the mixture to a point below that required to readily support burning (about 11 percent), has a smothering effect that will control fire in some light flash fuels. There is needed, however, a feasible method of cooling the exhaust gas, without increasing the oxygen content beyond the tolerable point, to give it greater control effect on hot fire in heavier fuels. Several methods have presented themselves, including injected water spray as a cooling agent. This will also serve to reduce the temperature of the fuel below its kindling point.

What could be done with an adequate supply of cooled exhaust gas and water vapor produced at the fire location from a few gallons of liquid fuel and water from a baby jet engine is still a question. Such engines having about 20 pounds thrust have just become available. A few field men are becoming interested in the possibilities of this combination and have proposed experimental trials.

Carrying Fire Canteens.—We have all experienced or observed the awkwardness of fire fighters trying to work and carry a 1-gallon canteen at the same time. Three systems of handling canteens are used:

a. They lay the canteens down and work, then come back and pick them up or forget them.

b. Hang them over their shoulders and wrestle with them.

c. Carry them on their backs by using a double sling for their shoulders. Many straps are too short for this system. As the fire fighters work the straps work down; or, if they don't, are too tight and cut beneath the arms.

It is recognized that the high nuisance effect of any piece of personal equipment is a great detractor from efficiency.

Suggested solution—rivet either canvas or leather straps to the flat side of the canteen covering and run a belt through them. The canteen then fits snugly in the small of the back and out of the way. I once used an Army cartridge belt to good effect. I have tried this system and it really works well.—NEAL M. RAHM, *Supervisor, Inyo National Forest.*

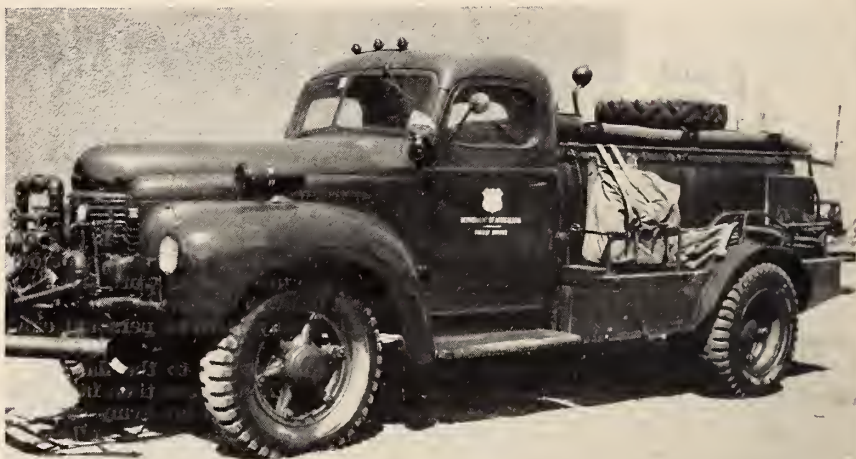
AN ARMY BRUSH TRUCK FOR FOREST FIRES

CHARLES D. SUTTON

General Foreman, Lincoln National Forest

The need of a truck equipped with tank and pump for fire suppression had been evident on the Lincoln National Forest for several years but lack of funds prohibited the purchase of such equipment. A very satisfactory unit was finally purchased for \$1,000 from surplus Army equipment at the Holloman Air Base near Alamogordo, N. Mex.

This unit consists of a 780-gallon tank and American Marsh F400 pump mounted on a K-5 International truck. It had been built in the shop of the post engineer at the air base for use in a range camp and required very few changes to adapt it for use in suppressing forest fires.



The pump is mounted on the front of the truck and driven by the truck engine. A throttle, clutch, and control valves are so arranged that the operator can stand in front of the truck and operate the unit. The pump is so connected that water can be pumped from the tank or from a stream or sump into the tank or directly into the discharge lines. All pipes and connections are 2-inch, and gate valves are so arranged that the operator has complete control from one position.

The suction line consists of two 10-foot lengths of 4-inch suction hose and strainer, and a 2-inch discharge line extends to rear of truck. A 1½-inch siamese connection on discharge line and a 1½-inch discharge

connection on the pump make it possible to operate one, two, or three lines simultaneously should they be desired. A vacuum primer mounted on the pump assures immediate suction when pumping from a stream or sump. The discharge line from the pump is equipped with a $\frac{1}{2}$ -inch hose to the radiator to aid in cooling the engine while pumping or going up steep grades when the engine would normally overheat.

In addition to the tank and pump the truck has a box constructed on the rear of each side platform and 200 feet of hose is folded in each box making it possible to lay 400 feet of hose in the shortest possible time. Additional hose is carried on the truck in pack sacks. Two $2\frac{1}{2}$ -gallon carbon-tetrachloride and three $2\frac{1}{2}$ gallon soda-acid fire extinguishers are mounted on the rear and side platforms and have proven quite successful in suppressing small fires. In addition to the extinguishers, axes, shovels, electric lanterns, and other items are carried on the truck. Two spot lights and a flood light mounted on the truck and tank are of much value at night. Spanner and pipe wrenches and small tools are carried in the truck making it possible to connect hose quickly and to make minor repairs and adjustments.

After experimenting with different nozzles it was found necessary to have both straight stream and fog nozzles with the truck and both types have proven quite satisfactory on different type fires. It is possible to fill the 780-gallon tank in approximately 2 minutes pumping time and to discharge the 780-gallon tank through two $1\frac{1}{2}$ -inch hose with straight stream nozzles in 5 to 6 minutes. Very unusual conditions would exist when water would be discharged at this rate. Normally fog nozzles are used and rate of discharge is held to the minimum for controlling the fire. The working pressure varies from 80 pounds to 150 pounds depending upon conditions and is controlled by the operator using the hand throttle on front of truck.

The first time this piece of equipment was used it made it possible to save a sawmill and planing mill. The shavings pile between mill and planer was on fire when the truck arrived. The water in the tank was sufficient to knock the flames down and prevent spread of the fire until water was turned into a nearby irrigation ditch. Water was then pumped from the ditch directly into the shavings pile and the fire completely extinguished. Since that time the tank truck has been used successfully on many fires in the recreational and summer resort area where it is maintained during the peak of the fire season and has paid for itself many times in property saved and forest fire suppression.

After 2 years of operation we wonder how the situation in this area was controlled without this piece of efficient and effective fire-suppression equipment.

SURVEYING FOREST SERVICE COMMUNICATION NEEDS

K. W. McNASSER

Forester, Jefferson National Forest

As this country developed, the communication facilities expanded to meet the greatly increased demands. Messenger type communication was rapidly supplanted by the telephone and telegraph, and the Nation became increasingly dependent on them for exchanging information.

During the first half of this century the scope of the work of the Forest Service called for a dependable and rapid means of communication. To protect and administer properly the natural resources of the national forests belonging to the people, this agency spanned thousands of miles with telephone line. In many areas the Forest Service systems were the only lines available. Early lines were primarily for protection; administrative use was incidental. Routine administration could ordinarily depend upon slower communication.

Gradually, the primary use of Service lines in some parts of the country turned toward administration; the advances made in protection having somewhat changed the picture. The Civilian Conservation Corps and other agencies had taken care of construction and maintenance during the 1930's. When these agencies ceased to function, maintenance became a problem. Just as the demand brought about an expansion in communication facilities so changing conditions called for reduction in certain types of communication. Commercial companies have moved in and are ready to furnish service to areas hitherto without any communication or dependent on Forest Service lines. The time is here to take careful stock of our needs and determine just what we must retain and what we should eliminate. Lines that recent communication plans for administrative units have revealed are no longer needed can be disposed of through sale, salvage, or cooperative agreements with other agencies or private companies.

The increased use of more efficient radio communication has entered very conspicuously into our planning. Miles of telephone wire and poles, located on miles of right-of-way, present a real problem of maintenance and cost. Radio seems to be one of the means of cutting down this communication expense. But radio is no panacea for communication problems. There still remain sections where wire communication is a necessity.

Radio, as a rule, is not used to reach individual warden crews in rural areas. If commercial wire is not available, then the Forest Service may be faced with the job of handling this situation through its own system. Generally year-round communication is not an abso-

Inte necessity on Forest Service lines but when these systems tie in with commercial exchanges or otherwise furnish an outlet for rural areas something of an obligation rests on the Forest Service to maintain service.

Radio will often make possible the abandonment of sections of line, leaving other sections isolated with no connection to commercial lines or to Forest Service headquarters. Radio communication to a look-out tower which also has telephone service on the isolated section will open up the entire communication network during the times of the year when the system is most needed for protection. Sections not absolutely needed present an unwarranted cost and cannot be justified. The new type TF frequency-modulated radio designed for use in look-out towers appears to be dependable to the extent that nonjustifiable wire sections can now be eliminated.

A study showed that on some units of the Jefferson National Forest a reduction in telephone mileage of nearly 50 percent will be possible in the next couple of years through communication replanning, commercial service can be purchased or secured through agreement, sections can be abandoned and salvaged or sold, and radio can be used to fill in the missing links.

Communication is no less important than heretofore. The exchange of pertinent information is a necessity on the fire line and in proper administration. However, we must survey the situation carefully to determine just where the needs exist.

A review of action on going forest fires has frequently revealed that communication between the various sectors has been inadequate—to the end that suppression action has suffered. The essential thing is that communication be maintained: the type should be that which best fits the situation. It may be foot messenger, temporary wire, portable radio, combination of portable and fixed station or mobile radio. Adequate communication will tend to prevent the confusion, and sometimes disaster, that results from a lack of knowledge of facts.

The type SF handy-talkie radio is probably the quickest means of establishing communication on a fire. Several of these sets will tie in the fire sectors with the fire boss. Type SF radio direct to a look-out tower having a type TF with its repeater will often give rapid and accurate data to the dispatcher. Sometimes, it may be more effective to clear messages from the fire line through a fire base radio which may be a mobile type KF installed in the ranger's or fire assistant's vehicle. The Jefferson National Forest used FM radio, types TF, SF, KF, and UF, during the spring fire season of 1949. In actual operation this equipment functioned up to or better than our expectations.

FM radio is another link in our communication chain, and it may make possible the elimination of less effective and more-expensive-to-maintain sections. This improved radio is certainly a reason for us to carefully scrutinize our communication set-up.

PROTECTIVE CASE AND JOINTED ANTENNA FOR FM HANDIE-TALKIE RADIO

W. S. DAVIS

Forester, Region 2, U. S. Forest Service

The Rocky Mountain Region recently made a test purchase of a small number of Motorola FM handie-talkie radios, intended as a means of communication with radio-equipped fire lookouts by rangers on trips in remote areas during periods of critical fire danger.

In its commercial version, the thin aluminum case and exposed hand set, antenna base, and switch of the radio did not seem to offer the set sufficient protection for rough usage on pack trips, surveys, timber sale work, etc. Therefore, a protective carrying case was devised.



Cases were made by a saddlery shop in Denver at a cost of \$22.50 each. Considering the purchase price of the radio, this is cheap protection. Each case is made of double saddle-stitched leather, with inside measurements of $3\frac{1}{2}$ by $10\frac{1}{4}$ by $12\frac{1}{2}$ inches. The carrying strap, with which the radio comes equipped, snaps into loops on the side of the leather case. The radio fits snugly in this container and is operated in place; removal is necessary only for maintenance or for the replacement of batteries.

The one-piece tapered steel rod antenna furnished with the handie-talkie could not be made to fit in the carrying case, so a substitute had to be devised. The screw socket was fastened to a jointed aluminum rifle cleaning rod, which was then cut to the length required by the transmitting frequency. The disassembled antenna sections are carried in a linen holster held in place by two leather snaps under the lid when the case is closed.

The complete case adds little bulk to the compact radio, and affords ample protection under practically all travel conditions.

GAS CAN HOLDER FOR PORTABLE PUMPS

EDWARD RUTTER

Forester, Region 7, U. S. Forest Service

How often have you, as a portable pump operator, looked for a limb, tree, post, or pole to hang the gasoline tank on, and found nothing suitable at the critical moment? Well, here is how Horace Remick, a warden for the State of Maine, at Ellsworth (near Bar Harbor) solved the problem. His oval holder may not be an entirely new innovation but its design, I understand, is original.



A piece of $\frac{1}{2}$ -inch galvanized water pipe, 23 inches in length, is ground down and tapered to fit snugly but easily into a $\frac{3}{4}$ -inch pipe nipple. The $\frac{3}{4}$ -inch pipe nipple, 4 inches in length, is fitted into a $3\frac{1}{2}$ -inch pipe flange. The flange is attached to an oval wooden base by four wood screws.

This base, which is used to support the gas can, was made to order for a special gas can in stock on the district. Three-quarter inch plywood was cut on an oval pattern, $12\frac{3}{8}$ inches the long way by $7\frac{3}{4}$ inches across the narrow side. The periphery was banded with a piece of $\frac{1}{8}$ -inch strap iron, $1\frac{1}{2}$ inches in width, to hold can in place. A short pin in the $\frac{1}{2}$ -inch pipe is fitted into a slot in the $\frac{3}{4}$ -inch nipple to prevent base from turning.

The upright piece of $\frac{1}{2}$ -inch pipe is held in place near the top by a guide clamp attached to the cylinder head, rack or protection rail, and its base is inserted in a hole bored into the carrying frame, which is reinforced by a block of 2 inches by 4 inches about 6 inches long.

Total cost for materials would probably be around \$3, but salvaged materials or pieces of scrap may be obtained for less.

REFLECTING WARNING SIGNS

E. L. BAXTER

Division of Fire Control, Region 5, U. S. Forest Service

Fire crews working on fires along busy highways have not been given adequate protection from fast moving vehicles. This is especially true at night because we have not had effective signs to warn the traveling public of the danger ahead.

Merve Adams, central dispatcher, Shasta National Forest, suggested we provide tank trucks and other vehicles assigned to fire control along roads with warning signs that could be placed on the edge of the roadway on both sides of the fire area and could be readily read day or night.



His suggestion has been accepted, such a sign has been developed and, after checking with numerous sign companies, bids are now circulating for reflecting warning signs. The size and wording of the sign are shown in the diagram. The sign will be on S $\frac{1}{2}$ hard .051 aluminum. The background is to be a bright red, the letters are to be silver. The entire sign will be treated with reflecting glass beads. This combination, as proved by numerous tests, gives a sign that is easily read at night by fast moving motorists. Of real importance in such signs is keeping the number of words down to not more than 5 since the driver of a fast moving vehicle can't pick up more than this number before passing the sign.

The sign will be riveted to the top bar of a swivel folding base that is made of two $\frac{1}{2}$ -inch pieces of square bar steel. The bottom bar fits inside two short feet at the ends of the top bar and the two are joined in the center by a large rivet that permits them to be opened to form a "+". This is sufficient base to hold the sign upright.

The advantage of this type of sign base over the orthodox type is that two signs will nest in a space a little over 1 inch thick, thus two signs can be fitted almost anywhere in a truck in a light wooden case, whose over-all dimensions are slightly larger than those of the signs.

EVOLUTION OF FIRE LINE PLOW DESIGN IN R-9

GUERDON L. DIMMICK

*Equipment Coordinator, Division of State & Private Forestry,
Region 9, U. S. Forest Service*

Two field demonstrations of equipment recently held in Missouri emphasized the progress made in fire line plow design and prompted this review of fire line plow history as it applies to Region 9 of the United States Forest Service.

Prior to the establishment of the Civilian Conservation Corps, fire suppression, and particularly line construction, was largely dependent on hand labor with axes, shovels, and back-pack pumps. Similarly tree planting, including ground preparation, was being done largely by hand labor.

Walking agricultural plows drawn by horses and small agricultural tractors had been used for years, but with the advent of the large CCC planting program there was an urgent need for larger and better plows to provide shallow, clean, wide furrows for planting, and that could be easily moved between jobs.

The CCC camp repair and blacksmith shop facilities and personnel afforded an opportunity for experimental development of suitable plows. In 1934 a 700-pound lister or middlebuster plow was designed and produced, but soon proved to be too light. A larger plow weighing approximately 1,500 pounds was produced in 1935. The larger tractors of the 30-hp. class and up which this plow required in turn presented additional transportation problems. Further study and local experimentation continued.

This study resulted in securing for testing a Killefer plow, made by the Killefer Corp. of Los Angeles, Calif., and successfully used as a wheeled ditcher plow in the West. Some changes in the plow bottom were suggested by Mr. Wagler, at that time an equipment sales engineer of Milwaukee, who had kept himself fully informed on the experimental work on plows.

The approval of this plow with the "Wagler" bottom, and the decision of the United States Forest Service to buy a quantity immediately posed a question as to a possible source of supply for such a specialized plow. Numerous contacts with commercial manufacturers developed a common pattern of disinterest due to the limited market for a specially designed agricultural plow. The Killefer Co., however, expressed their interest, and a considerable number of Killefer plows known as model 77 were subsequently built by Killefer as designed by Mr. Wagler and purchased by the Forest Service for the Civilian Conservation Corps program.

Certain limitations in the Killefer plow were found through experience, indicating that heavier plows and heavier tractors were essential.

Two years later (1938) the plans for a radically new plow came from Mr. Wagler's drafting board. They included a special design in moldboard construction which furnished a marked improvement in the type of planting furrow.

The plow, with a 42-inch rolling coulter encased in a heavy steel housing, was designed without a sulky and weighed 2,600 pounds. Because of its weight and nonmobility it was extremely cumbersome and difficult to handle when uncoupled from the tractor; but on furrowing and fire line construction it outperformed all its predecessors



Original ditcher plow purchased from Killefer in 1934.

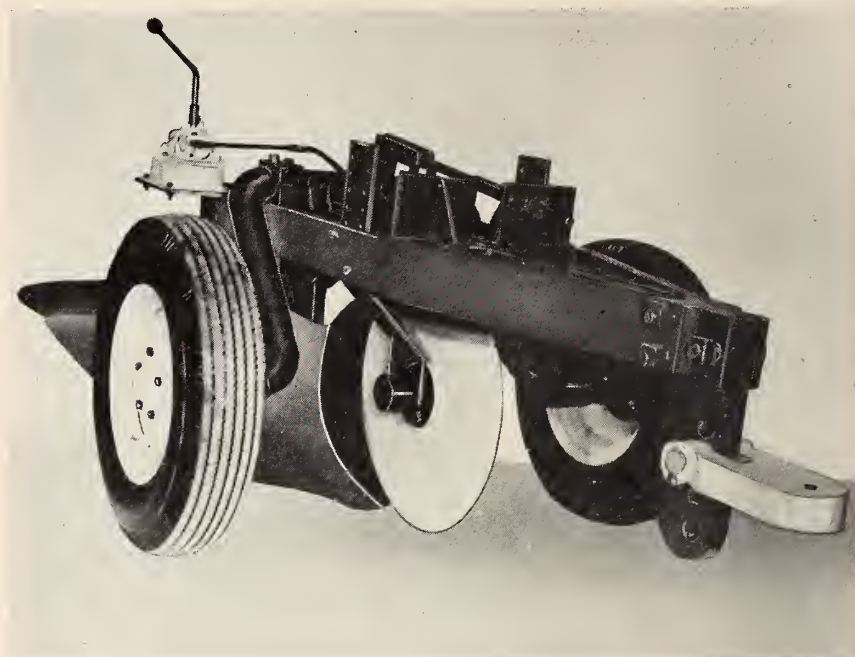
with little or no maintenance. Again the Killefer Corp. was the only commercial manufacturer who would agree to build this plow. It subsequently delivered 57 units known as the Wagler fire line plow to Region 9.

The inactivation of the Civilian Conservation Corps program and the advent of war resulted in much of the CCC equipment, including many tractors, being turned over to the armed services, thereby leaving this latest plow as a surplus item because of its weight and lack of mobility.

The design and production of this type of equipment, drastically curtailed throughout the war years, has experienced a revival in the past 2 years. Neil LeMay, Chief Forest Ranger for Wisconsin, had been favorably impressed by the performance of the Wagler non-mobile plow. He acquired a number of surplus plows, removed the

moldboard assemblies from the original plows and mounted them on specially constructed sulkies. The result is considered to be one of the most satisfactory fire line plows built to date for the types of fuels and ground conditions found in this area. These units, used with 30-hp. crawler tractors, are transported on two-wheeled tilt-bed trailers and constitute the State's best initial attack plow units.

During the spring fire season of 1947 Mr. LeMay was in Missouri to study their radio fire communication system and while there had an opportunity to participate in fire suppression work. After a night



Wagler model 30A plow in present use.

of back-breaking and hand-blistering work fighting fire, he stated that he felt Wisconsin's latest converted Wagler plow would work in Missouri and offered to demonstrate it by bringing a tractor plow unit to Missouri on a tilt-bed trailer.

As the result of the subsequent request of Missouri State Forester White, Wisconsin put on a plow demonstration for State and Federal representatives at Sullivan, Mo., in the spring of 1948. Wisconsin's converted Wagler plow fulfilled the expectations of the sponsors to the satisfaction of the fire technicians present.

The United States Forest Service and Missouri both wished to acquire similar plows. The revival of interest again presented the familiar problem of where to get this type of plow. Killefer Corp. had been sold and the facilities of their successors were closed to production of experimental models for outsiders. Other possible sources were more restrictive than before the war. This problem was solved by the Wagler Equipment Co. whose new factory at Pewaukee, Wis.,

was dedicated to the production of specially built equipment for forest use by National, State, and private agencies.

The first Wagler heavy-duty, mobile fire plow was produced in 1948 and taken to Wisconsin State Fire Headquarters at Tomahawk for a comparative test with the Wisconsin converted plow before a group of State and Federal fire technicians. After the test definite suggestions concerning possible improvements or changes were obtained from the group.

The final approved model incorporating the suggested improvements was completed in November 1948 and taken to Missouri for its final demonstration before 70 State and Federal representatives under carefully selected conditions that would thoroughly develop any possible limitations.

The plow's performance won the unanimous approval of the group, and units were purchased by the United States Forest Service and the State of Missouri. The State of Minnesota was also impressed by the possibilities of this unit and has purchased 15 for fire suppression work in that State.

Some of the features that merited favorable comment at the Missouri demonstrations are as follows:

1. The trim appearance, simplicity in design, and rugged construction around a 3-inch axle of unique design.

2. Its extreme portability and roadability at high speeds due to its low center of gravity, perfect balance, automotive type wheels, pneumatic tires, and high speed axles.

3. Its 34-inch wide lister or middlebuster type moldboard assembly equipped with easily replaceable agricultural type shares and moldboards mounted on specially designed permanent boards, heavily cross-braced to withstand great compression loads.

4. The elimination of side bracing for the brackets of the bronze-bushed, 30-inch, rolling coulter which can be adjusted to conditions of terrain.

5. The effective screw type depth adjustment with integral locking device for adjustments from transport position to a 10-inch plowing depth.

6. Simple, sturdy, well-located, hand-operated, hydraulic lifting mechanism.

7. Sturdy tractor hitch attached to frame readily adjustable to various tractor drawbar heights.

The Wagler plow although weighing 2,080 pounds was transported by passenger car with a rigid bumper hitch from Milwaukee, Wis., to Sullivan, Mo., a distance of 497 miles, at an average rate of more than 40 miles per hour without any difficulty.

This high speed portability of the fire line plow is of particular interest to fire control personnel as it permits a greater flexibility in the use of fire equipment, especially where policy precludes the exclusive assignment of equipment for fire suppression purposes as in the national forests. Under such a policy trucks, trailers, and tractors would be released for other work.

Further information and specification will be furnished upon request by the Regional Forester, United States Forest Service, Madison Building, Milwaukee 3, Wis.

THE PLUMAS MACHINERY TRAILER

M. D. STOWELL

Fire Control Staff Officer, Plumas National Forest

Experienced fire men know the value of heavy bulldozer equipment on slash, timber, and brush fires in the West. It has been estimated that one D-8 bulldozer, properly operated on such fires, is equivalent to 50 good men in constructing fire line.

This Forest has used mechanized equipment on fire line construction for some time. Our problem has been in getting such equipment to fires in time to be of value in line construction. For years, the Forest had a light dozer and transport on fire standby during the fire season, but the transport was slow and the dozer, because of weight limitations of the transport, was not large enough to do some of the heavy work desired on fire line construction.

There are some 20 logging operations on this Forest, all of which have one or more D-7 or D-8 dozers or their equivalent. Operators are willing to use their equipment on fires when needed, but only a few have transports.

It was recognized that these logging operations had logging trucks, the tractor units varying from 140 to 250 horsepower. These tractor units are powerful enough to furnish motive power for a trailer transport to haul large dozers.

There are several commercially manufactured machinery trailers on the market but each of them had some drawback when tried for hauling fire equipment on back-country roads.



View of detailed hookup on log bunk or tractor unit of logging truck.

A survey of the few machinery trailers in use in this area brought to light a trailer designed, built, and used for 7 years by the Graeagle Lumber Co., Graeagle, Calif., which seemed to fit our needs more closely than any commercial or surplus unit.

The main features of this trailer are as follows:

1. It is quickly and easily attached to the log bunk of the tractor unit of a logging truck.
2. Dozers can be quickly loaded and unloaded on any road without using planks or a bank or ramp.
3. It is possible to rent a tractor unit to furnish power for the trailer only when needed, and to get one with sufficient power to haul a D-8 with dozer blade and double drum winch at speeds commensurate with road conditions.
4. The unit can be maneuvered like any semitrailer unit.



A D-8 dozer being loaded on trailer from a level site. Some blocking is necessary to raise blade and tracks to start up ramp. A folding metal ramp is being fabricated to replace blocks.

It was decided to build a similar trailer unit as an experiment to answer the need for a trailer-transport and to dispense with the standby dozer and costly transport. Accurate costs were kept on the construction of this trailer to determine the feasibility of constructing others to replace standby transports in areas where logging trucks and dozers are available through private concerns but transports are not.

Bids were let for a trunnion type, dual-axled, 8-wheel logging trailer under gear, with a conservative loading potential of 50,000 pounds

for each axle. The unit purchased was equipped with air brakes, 10.00 x 20 wheels, coil spring suspension, and cost \$1,828.69 delivered.

Steel I beams and channels, plates, welding rod, etc., on bid cost \$579.84. Twelve-ply tires, tubes, clearance lights and air brake controls cost an additional \$608.62. Labor for 25 man-days cost \$314.50, making the total cost to the Forest for this trailer \$3,331.65. This amounted to approximately 2-years' rental cost for the standby dozer and transport. It is estimated that the trailer will be serviceable for at least 10 years with very little maintenance. Over that period there will be a considerable saving of public funds.



Side view of truck and trailer with D-8 dozer in final loaded position.

The trailer was constructed in our forest shops by Welder E. J. Kessler in 1948. Equipment for such construction was inadequate, but through the interest and ingenuity of Welder Kessler the unit was constructed in a minimum of time.

Initial tests on highway hauling were made in the spring of 1949. A 140-horsepower logging truck tractor unit was used for motive power and the pay load was a 28-ton D-8 with dozer blade and winch. This load was hauled 12 miles. The unit traveled up 7-percent grades at 8 m. p. h., on the level at 15 to 20 m. p. h., and down grades at safe speeds of up to 28 m. p. h. with this load. The dozer rode well, the trailer tracked and handled perfectly, and the moving operation was carried on in a minimum of time. Loading the trailer on the tractor unit requires about 15 minutes. Loading the dozer and securing it with blocks and load binders requires 15 to 20 minutes and unloading about 10 minutes. When the trailer is empty the truck travels at 40 m. p. h. on standard highways.

The entire trailer is 33 feet long, the bed is 53 inches high and 96 inches wide. It weighs approximately 12,500 pounds.

This trailer is one of several that could function in the capacity intended. It is not recommended that these trailers be built in a forest shop as the steel used in its construction is too heavy to be handled by the light equipment usually available.

OLIVER TRACTOR-TANKER-PLOW UNIT

EINAR E. AAMODT

*Engineer, Roscommon Equipment Development Center, Region 9,
U. S. Forest Service*

A new fire-fighting tool, a tractor-tanker-plow unit which is almost in a class by itself, has been developed around a new H. G. Oliver tractor. The initial demonstrations and tests of this unit proved it to be very satisfactory. The tractor is equipped with two 45-gallon tanks, a Porto pump with chain drive from the main drive shaft and a hand-operated clutch to engage the pump unit, a hydraulic lift control unit and stubby plow, a pusher bumper, and a nozzle gun support. It is lightweight (about 5,400 pounds loaded with water) and can be hauled easily on stake trucks or a light R-8 tilt-top trailer. It is fast on easy, open going; and in heavy going it can build a good line under almost any condition. Its small size permits getting around and through places where larger plow units have trouble. There is no lost time due to hang ups, and under the toughest conditions the plow does not clog up. The unit can be used for mop-up with the tanker or as a stationary pump using 1½-inch hose.

The pusher bumper, a hydraulic-controlled short-width dozer, is very useful in mop-up, and to clear out logs and slash or debris in line construction. The hydraulic control unit on the plow is also a decided advantage and improvement. The plow can be quickly raised or lowered while the tractor is standing or in motion. It is possible to put



Tractor-tanker-plow unit, showing water tank over crawler track, nozzle gun on swivel support, and hydraulic-controlled bumper dozer.

800 to 1,000 pounds pressure on the plow, in fact enough to raise the rear end of the tractor off the ground. The dozer and plow can be raised or lowered together or each unit operated independently. The plow is a standard straight coulter stubby plow with standard 14-inch plow bottoms and a reinforced hitch. A heavy spring loading arrangement is used on the plow to allow it to slide over large rocks or stumps to prevent damage to the plow. The downward pressure on the plow



Tractor-tanker-plow unit with a hydraulic-controlled plow in operation.

is through this spring and the pressure can be varied instantly by manipulation of the hydraulic control lever.

Two water tanks, each of 45-gallon capacity, are mounted directly to each crawler track. There are advantages in mounting the tanks to the tracks rather than to the frame of the tractors. The cost of this mounting is less and the work required is also less. Overload springs are not required, the water weight is distributed equally to each track which gives better traction. The tanks are mounted low and close to the tracks, which is important from a safety standpoint when the unit is traversing steep hillsides and slopes. A flexible hose from each tank is run through a slotted hole in each fender to the pump unit which is located in the center of the tractor above the transmission and just ahead of the operator. The tanks are constructed of 16-gauge sheet iron and are welded over a $\frac{1}{4}$ by 1 by 1-inch angle iron frame into a one-piece unit. They are heavily coated with Neutral, and have removable covers and filter caps. By removing the covers the tanks

can be cleaned out or coated again with Nentral. The tanks and mountings showed no weaknesses after vigorous tests.

The bronze case model Porto pump has rubber impellers and can pump dirty and muddy water without damage. The pump runs at the same speed as the engine and is driven by a simple roller chain drive off the rear of the clutch housing. A jaw type clutch is used to engage the pump, and the handle is within easy reach of the operator. An adjustable water-pressure by-pass valve is also located within easy reach of the operator. Pressures can be varied up to 220 pounds. An operating pressure of about 150 pounds was found to give the best results with a Hardie gun nozzle, using a 10/64-inch tip and discharging about 8 gallons per minute. The tractor carries suction hose and strainer mounted in clips, and these can be easily and quickly removed or replaced. The tractor can be driven to a nearby source of water for refilling the tanks. The Hardie nozzle is mounted on a two-way swivel so the gun can be directed in any direction or locked in any position. The gun can be easily detached from the holder. On the swivel, the gun can be handled with one hand and it remains fixed in any position as soon as the operator lets go. This allows the operator time to manage the other controls and to steer the tractor. On initial attack the water is primarily used to knock down the hot spots.

HOSE WASHING AND DRYING RACK

NEIL LEMAY

Chief Forest Ranger, Wisconsin Conservation Department

An effective and durable steel rack for washing and drying hose has been in use at the Rhinelander Ranger Station.

The rack is constructed of 2-inch galvanized pipe and has over-all dimensions of 60 by 6 feet, with a slope of 2 feet in the total length. The uprights may be bent at an angle of 2° to accommodate the slope. However, the Rhinelander rack has regular T's on the side connections and the uprights are welded to the T's at a 2° angle.



Hose washing and drying rack with rewind trough and portable hose winder, at Rhinelander Ranger Station, Rhinelander, Wis.

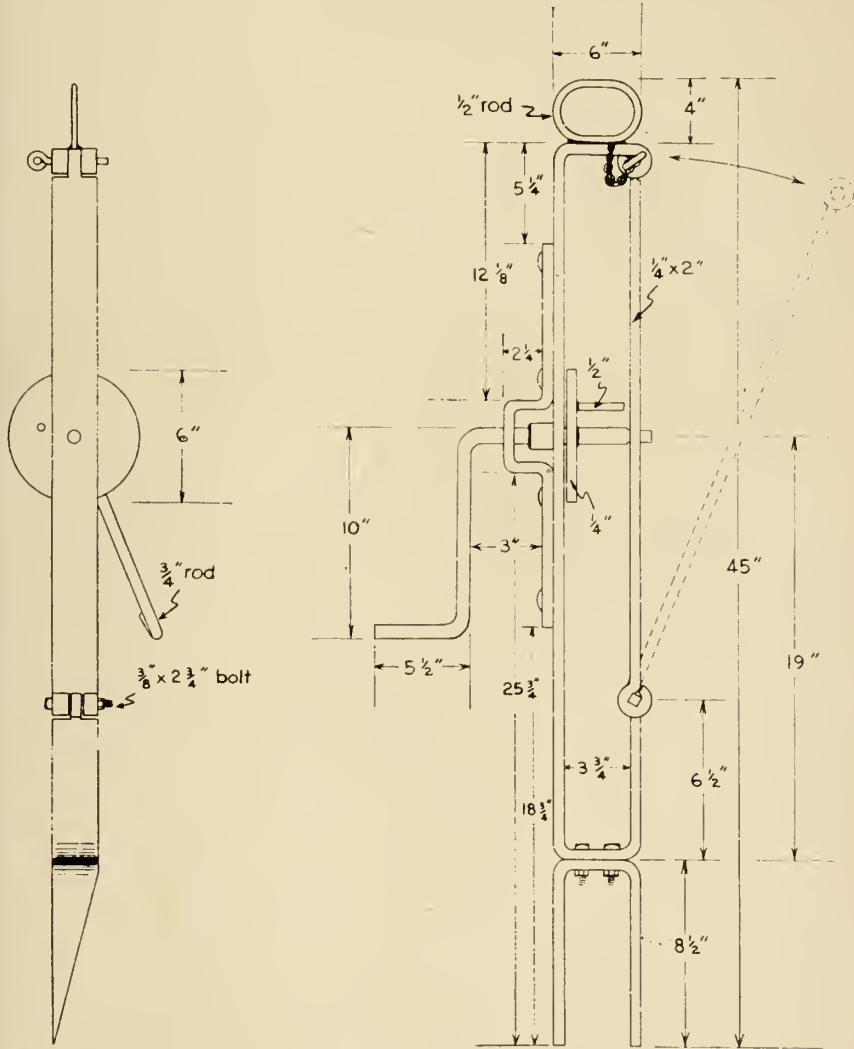
The galvanized wire mesh covering the rack is warped over the edge of the frame and fastened by using No. 9 wire, 1-foot spacing, and then twisting up the wire to pull the mesh into a taut position. The end sections have such wiring in both directions to hold both the ends and sides of the wire mesh. There is some sag but not sufficient to warrant turnbuckles.

The rewind trough is a more recent addition to the rack and is made of sections of two pieces of 3- by $\frac{3}{32}$ -inch angle iron bolted together and supported by 2- by $\frac{1}{4}$ -inch brackets bolted to the uprights.

One of our standard portable hose winders has been fastened to the end of the drying rack opposite the rewind trough, and it has been found to be a quick and effective means of rewinding the hose after it has been washed and dried. The plan of this winder shows the

sharpened foot only $8\frac{1}{2}$ inches long; this base has been lengthened for attachment to the rack.

The steel rack with its concrete footings has proved extremely durable and the wire mesh has facilitated rapid drying of the hose. Wooden structures are bulkier and are in constant need of painting and repair.



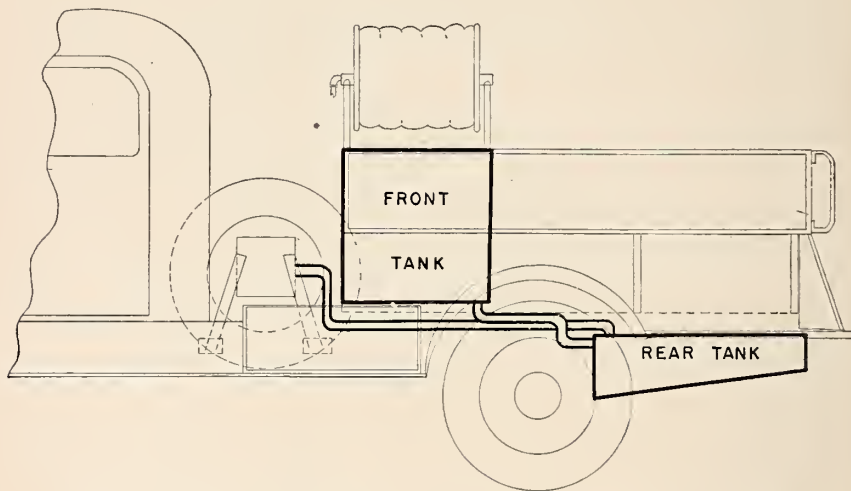
Portable hose winder.

CORRECTING LOAD DISTRIBUTION ON TANK AND CREW TRUCKS

DEWITT NELSON

State Forester, California Division of Forestry

The California Division of Forestry, like most other suppression organizations, has always experienced difficulty in maintaining proper load distribution on combination tank and crew trucks. To a large degree this is due to our policy of carrying personnel at the rear of the truck, thus throwing the water and pump weight toward the front axle.



Position of tank installations for combination tank and crew truck.

We believe that we have overcome this problem to a satisfactory degree by adopting the use of a rear tank suspended from the frame back of the rear axle. For our particular designed truck we are using a tank with a capacity of 53 gallons, constructed of $\frac{3}{16}$ -inch plate with cross baffles and cover of 10-gage iron. The unit is 12 inches deep at the front, 6 inches at the rear, 38 inches long and 36 inches wide. There are two $\frac{1}{2}$ - by 2-inch pieces of flat iron welded full height of tank on each side, 4 inches from each end; these brackets extend above the tank to the height of the frame to which they are bolted with $2\frac{3}{8}$ -inch bolts in each carrier. The entire completed unit is hot-dip galvanized before being installed.

Water is supplied by gravity from main tank by means of a pipe one-half inch larger in diameter than the filler line from the pump discharge into the main tank. The suction line from the lower tank to the pump is regulated according to the capacity of the pump. We also have an air vent from the rear tank back into the main tank.

The tank is installed 10 inches back of the differential center line and has a ground clearance of $15\frac{1}{2}$ inches at that point against $9\frac{1}{2}$ inches at the differential; the least clearance of the tank is at the extreme rear where it is 42 percent of the overhang.

The total weight of this unit is 9,850 pounds without personnel. with a weight distribution of 68 percent on rear axle and 32 percent on front; with a full complement of eight men, the load distribution is 76 percent rear and 24 percent front.

The drawing illustrates the general arrangement of the last 68 units we put in service during the past fire season.

CONVERTING A STANDARD JEEP INTO A MOBILE FOREST FIRE FIGHTING UNIT

D. A. ANDERSON and E. F. EVANS ¹

This article briefly describes the result of the pioneering work of the State of Texas in developing the jeep and accessories for fire suppression work. Further development is now being sponsored by the Lake States and Region 9 of the United States Forest Service with the objective of perfecting well-balanced and standardized outfits that can be mass produced at lower cost. Principal manufacturers of the vehicle and accessories are cooperating in this project.—*Ed.*

A standard jeep requires a number of modifications to convert it into a forest fire fighting unit. Much of this transformation is for the primary purpose of reinforcing the body and chassis to withstand the heavy duty required on the fire line. The factory-equipped jeep filled with gasoline and oil weighs 2,220 pounds. A jeep forest fire fighting unit, as modified by the Texas Forest Service, weighs approximately 3,550 pounds and costs approximately \$2,899 as indicated in the following tabulations.

	<i>Weight in pounds</i>
Jeep, factory equipped with full tank of gas and oil.....	2, 220
Shop-built plow and mountings.....	300
Extra tools.....	25
Radio, accessories, and radio box (estimated).....	100
Steel top.....	268
Lift.....	152
Winch.....	152
Front grill, front and rear bumpers, frame reinforcement, and miscellaneous.....	333
Total.....	3, 550

	<i>Estimated cost</i>	
	<i>Single units (dollars)</i>	<i>In quantity (dollars)</i>
Jeeps, less tops, with dual adapters, tires, and wheels for placing dual wheels on jeeps (one unit); tire size 700 x 15.....	1, 445	1, 245
Special design body unit, 13- to 18-gage metal.....	150	120
Special design plow, grills, belly plate, and painting.....	125	90
Coulter, 18-inch, rolling.....	9	9
Koenig winch.....	250	225
Farm-Aid lift with "Power Pack" hydraulic mechanism.....	250	225
Radio, FM, 250-watt, transmitter and receiver.....	575	450
Metal special design radio box.....	25	23
Back-pack fire pump, 5-gallon, complete.....	25	23
Special design backfire torch.....	15	10
Miscellaneous extra repair tools, including wrenches, etc.....	30	25
Total.....	2, 899	2, 445

¹ Respectively, Head, Research and Education Department, and Acting Chief, Education Section, Texas Forest Service, A. & M. College System, College Station, Tex.

Body.—The canvas top is replaced with a 16-gage metal top. Supporting this metal top is a frame made of 1-inch angle iron three-sixteenths inch thick. Stiffeners made of 16-gage metal extend the full length of the top on the interior side. Three metal datum holders are built into the roof near the driver's seat and a tool box is built at the right rear. Canvas doors are used on each side of the jeep.

Protection of undercarriage.—Protection for the lower side of the jeep is afforded by three belly plates. One plate, of metal one-fourth inch thick, extends from the front bumper to the radius rods. One additional small plate of 12-gage metal protects the speedometer housing. Another small plate of the same material protects the emergency brake drums. Fenders are reinforced with flat iron one-fourth inch thick by 1 inch wide.

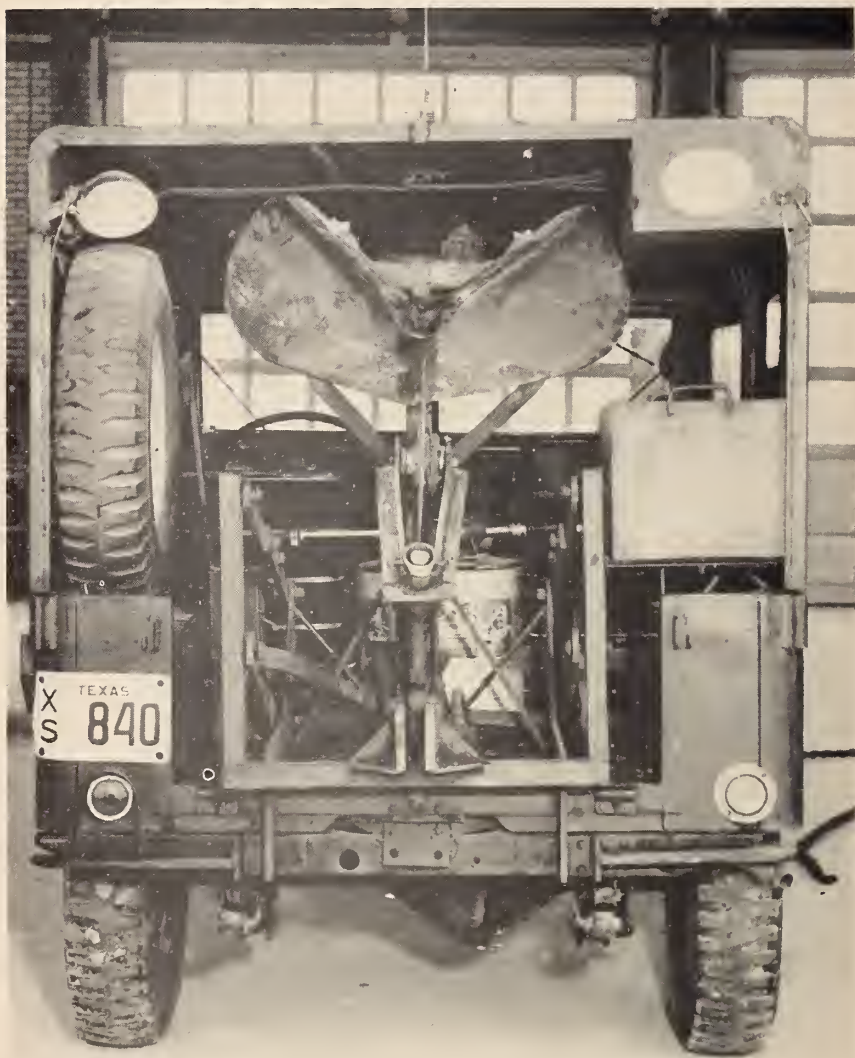
Front grill.—A front grill, made from pieces of flat iron three-eighths inch thick by 1 inch wide, protects the radiator and engine on the fire line. The grill has, at each end, a slanting flat iron brace of the same dimensions. This type of grill and the type made of $\frac{3}{4}$ -inch black iron pipe are used on Texas Forest Service jeep units. The grill is welded to an auxiliary front bumper which consists of a $2\frac{1}{2}$ -inch black pipe. This adapted bumper extends slightly beyond



Texas Forest Service fire fighting jeep showing protective grill and winch.

the outer edge of the wheels to give added protection to the tires. The tubular bumper is attached to two pieces of flat iron which are bolted to the original bumper near its end. There are two rear bumpers constructed from pieces of metal 4 inches wide by one-half inch thick.

The front end of the frame is reinforced with an L-shaped metal member extending from the bumper to the rear of the front shock absorber. This reinforcing member is bolted at front and rear and welded every other inch. Weight of the front grill, front and rear bumpers, and frame reinforcement is approximately 308 pounds. Heavy duty springs are used on the modified jeep.



Texas Forest Service fire fighting jeep, showing retracted fire plow, spare tire, back-pack water pump, spotlight, and enclosed radio.

Winch unit.—A Koenig one-way winch is bolted to the standard bumper. The winch operates from the engine drive shaft. Gear ratio between winch drum and engine is 72 to 1. Gear ratio within the winch is 36 to 1. Attached to the winch is a $\frac{3}{8}$ -inch cable 150 feet long with hook. Safe working load of the winch is 2,500 pounds, although the winch is tested up to 9,860 pounds. A chain 25 feet long is used with the winch cable for off-center pulling. This chain is equipped with a quick release attachment for disconnecting the chain while cable is taut. Use of the chain reduces the risk of upsetting the jeep when the pull of the cable is not in a straight line. The winch with complete installation weighs 126 pounds. The cable with hook weighs 26 pounds. A bottom roller has been added to the winch cable guide.

Plow unit.—A middlebuster type plow is used with the jeep unit. The shares are at present made of grader blades and hard surfaced. Each plow share has a length of $23\frac{1}{2}$ inches, and the distance between the rear points of the shares is $23\frac{1}{2}$ inches. The plow shares are approximately one-half inch thick. The plow wings have a span of 34 inches. The plow point is one-fourth inch below the share when the share is flat on the ground. Two pieces of flat iron reinforce the wings. A flat iron brace extends from each wing to the plow beam. The plow is designed to run a minimum depth, and furrows are plowed as shallow as possible. Width of the furrow depends somewhat on depth of plowing.



Texas Forest Service fire fighting jeep, showing coulters and fire plow in position for constructing fire lines and radio with protective cover removed.

The U-frame for the plow is made of 3-inch channel iron on the uprights and 4-inch channel iron on the bottom. A flat plate has been added to make a hollow rectangular member. The U-frame is attached to the four arms of the Farm-Aid hydraulic lift, and has a level adjusting crank. The plow beam is $1\frac{1}{4}$ by 3 inches. It is attached to the bottom center section of the U-frame by two bolts, one of which is removable to permit folding of plow into jeep. When lifted to traveling position the plow fits into a carrying rack. A bolt on the carrying rack locks the plow in traveling position. The same bolt is used to lock the plow in plowing position. This bolt is machined for a tight fit in both positions. The L-shaped plow beam is reinforced at the right angle.

The upright shaft of the 16-inch rolling coulter is attached to the plow beam. A piece of metal reinforces the coulter shaft. The coulter is $1\frac{1}{2}$ inches from the point of the plow.

Hydraulic lift.—The Farm-Aid hydraulic lift is powered by a pump driven by a crankshaft pulley. Another pulley drives the generator, water pump, and fan. Two gallons of SAE engine oil are used in the reservoir of the hydraulic pump. The hydraulic lift used in the Texas Forest Service jeep unit is the single-action type. The single-action hydraulic lift permits the coulter to jump roots and other objects which it cannot cut, thus allowing the plow to jump over the objects instead of hooking under them. The hydraulic cylinder ram has a spin down (jam nut) depth adjuster which permits adjustment of the plow in the event of hydraulic failure. A covering of old inner tube is used to keep dust out of the cylinder system of the hydraulic lift.

To facilitate the plowing of fire lines at night, a light is attached at the upper left rear corner of the jeep top. This light has a separate switch on the dashboard.

Radio.—Radio equipment is an important feature of the jeep unit. Each jeep is equipped with a 50-watt two-way mobile unit with dual channel transmitter.

The receiver has a single frequency of 31.3 megacycles. The transmitter has a dual frequency of 31.3 and 31.42 megacycles. A roof-top antenna is used. The jeep top has a 12-inch square, 16-gage reinforcing plate under the antenna. Receiving and transmitting radius of the jeep unit is 60 miles when communicating with fixed station antennae that have a height of 150 feet. Radio equipment is shock mounted on radiator hose. The cover of the radio equipment is 16-gage metal.

Wheels.—Dual wheels are used in the operation of the jeeps in low swampy land. The 7.00 x 15 wheels are equipped with military grip or studded grip tires.

Color of jeep.—Luzon red is the standard color of the jeep units.

Jeep operation.—The jeep pulls the fire plow in first or second gear in low range. Most vehicles are equipped with factory-installed Monarch or King Seely governors. The speed is adjustable. Plows are pulled at a motor temperature of about 180 degrees with governor and about 195 degrees without governor.

[Further detailed information, such as sources of supply, regarding the accessories described above may be obtained by writing the Director, Texas Forest Service, College Station, Tex.]

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

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